Downloaded From : www.EasyEngineering.net

GATE SOLVED PAPER - EE

2014-1

General Aptitude

Q. 1 - Q. 5 Carry one mark each

Q. 1 Which of the following options is the closest in meaning to the phrase underlined in the sentence below ?
It is fascinating to see life forms cope with varied environmental conditions.
(A) adopt (B) adapt to
(C) adept in (D) accept with

Sol. 1 Correct option is (B).
cope with: presented by
To over come any difficulties presented by: adapt to

Q. 2 Choose the most appropriate word from the options given below to complete the following sentence.
He could not understand the judges awarding her the first prize, because he thought that her performance was quite _ _ _ _ _ _ _ _ _ _.
(A) superb (B) medium
(C) mediocre (D) exhilarating

Sol. 2 Correct option is (C).
By the incomplete statement, we conclude that his performance is just ordinary or not special or medium quality so it comes in mediocre.

Q. 3 In a press meet on the recent scam, the minister said, “The buck stops here”. What did the minister convey by the statement ?
(A) He wants all the money
(B) He will return the money
(C) He will assume final responsibility
(D) He will resist all enquiries

Sol. 3 Correct option is (C).
He will assume final responsibility.

Q. 4 If $(z+1/z)^2 = 98$, compute (z^2+1/z^2).

Sol. 4 Correct answer is 96.
Given that

$$\left(z+\frac{1}{z}\right)^2 = 98 \qquad \text{...(i)}$$

and we have to determine

$$\left(z^2+\frac{1}{z^2}\right) = ?$$

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Since, $(a+b)^2 = a^2 + b^2 + 2a \cdot b$

Applying this formula in equation (i), we get

$$\left(z + \frac{1}{z}\right)^2 = 98$$

or $$z^2 + 2.z.\frac{1}{z} + \frac{1}{z^2} = 98$$

or $$z^2 + \frac{1}{z^2} = 98 - 2$$

So, $$z^2 + \frac{1}{z^2} = 96$$

Q. 5 The roots of $ax^2 + bx + c = 0$ are real and positive. a, b and c are real. Then $ax^2 + b|x| + c = 0$ has

(A) no roots (B) 2 real roots

(C) 3 real roots (D) 4 real roots

Sol. 5 Correct option is (D).

Given the quadratic equations,

$$ax^2 + bx + c = 0 \quad ...(i)$$

and $$ax^2 + b|x| + c = 0 \quad ...(ii)$$

In equation (ii), $|x|$ has two values $+x$ and $-x$. So, it may be resolved into two equations

$$ax^2 + bx + c = 0 \text{ with roots } (\alpha_1, \alpha_2)$$

and $$ax^2 - bx + c = 0 \text{ with roots } (\beta_1, \beta_2)$$

Hence, there are total 4 real roots.

Q. 6 - Q. 10 Carry two marks each

Q. 6 The Palghat Gap (or Palakkad Gap), a region about 30 km wide in the southern part of the Western Ghats in India, is lower than the hilly terrain to its north and south. The exact reasons for the formation of this gap are not clear. It results in the neighbouring regions of Tamil Nadu getting more rainfall from the South West mansoon and the neighbouring regions of Kerala having higher summer temperatures.

What can be inferred from this passage ?

(A) The Palghat gap is caused by high rainfall and high temperatures in southern Tamil Nadu nad Kerala

(B) The regions in Tamil Nadu and Kerala that are near the Palghat Gap are low-lying

(C) The low terrian of the Palghat Gap has a significant impact on weather patterns in neighbouring parts of Tamil Nadu and Kerala.

(D) Higher summer temperature result in higher rainfall near the Palghat Gap area.

Sol. 6 Correct option is (C).

Passage summary gives the conclusion:

The low terrian of the Palghat gap has a significant impact on weather pattern in neighbouring parts of Tamilnadu and Kerala.

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Q. 7 Geneticists say that they are very close to confirming the genetic roots of psychiatric illnesses such as depression and schizophrenia, and consequently, that doctors will be able to eradicate these diseases through early identification and gene therapy.
On which of the following assumptions does the statement above rely ?

(A) Strategies are now available for eliminating psychiatric illnesses

(B) Certain psychiatric illnesses have a genetic basis

(C) All human diseases can be traced back to genes and how they are expressed

(D) In the future, genetics will become the only relevant field for identifying psychiatric illnesses

Sol. 7 Correct option is (B).
Strategies are now available for eliminating psychiatric illness.

Q. 8 Round-trip tickets to a tourist destination are eligible for a discount of 10% on the total fare. In addition, groups of 4 or more get a discount of 5% on the total fare. If the one way single person fare is Rs 100, a group of 5 tourists purchasing round-trip tickets will be charged Rs _ _ _ _ _ _ _ _.

Sol. 8 Correct answer is 850.
Total round trip fare for group of 5 tourist without discount

$$= 5 \times 200 = \text{Rs.}1000$$

(i) $$\text{Discount for round trip} = 10\% \text{ of total fare}$$

$$= \frac{10}{100} \times 1000 = \text{Rs.}100$$

(ii) $$\text{Discount for having a group of 5 tourist} = 5\% \text{ of total fare}$$

$$= \frac{5}{100} \times 1000 = \text{Rs.}50$$

Total discount = Discount for round + Discount for having a group of 5 tourist.

$$= 100 + 50 = \text{Rs.}150$$

Thus, the net round trip fare for group of 5 tourist after discount is

$$\text{Net fare} = \text{total fare} - \text{total discount}$$

$$= \text{Rs.}1000 - \text{Rs.}150$$

$$= \text{Rs.}850$$

Q. 9 In a survey, 300 respondents were asked whether they own a vehicle or not. If yes, they were further asked to mention whether they own a car or scooter or both. Their responses are tabulated below. What percent of respondents do not own a scooter ?

		Men	Women
Own vehicle	Car	40	34
	Scooter	30	20
	Both	60	46
Do not own vehicle		20	50

Sol. 9 Correct answer is 48%.

Total respondents = 300 (150 men + 150 women)

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

$$\underset{\text{(car)}}{\text{150 men}} = \underset{\text{(car)}}{40\text{ men}} + \underset{\text{(Scooter)}}{30\text{ men}} + \underset{\text{(Car \& Scooter)}}{60\,(\text{men})} + \underset{\text{(Nothing)}}{20\,(\text{men})}$$

Total number of men who owns car $= 100$

Total number of men who owns scooter $= 90$

Total number of men who do not own a scooter $= 60$ ...(i)

$= 40(\text{car}) + 20(\text{nothing})$

$$\underset{\text{(car)}}{\text{150 women}} = \underset{\text{(car)}}{34\text{ women}} + \underset{\text{(Scooter)}}{20\text{ women}} + \underset{\text{(Car \& Scooter)}}{46\text{ (women)}} + \underset{\text{(nothing)}}{50\text{ (women)}}$$

Total number of women who owns car $= 80$

Total number of women who owns scooter $= 66$

Total number of women who do not own a scooter $= 34(\text{Car}) + 50$ (Nothing)

$= 84$ ...(ii)

Percent of respondents who do not own a scooter

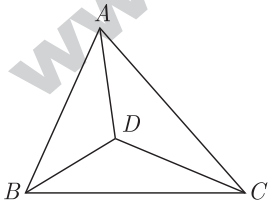
$$= \frac{(\text{men} + \text{women})\text{who do not own scooter}}{\text{Total respondents}} \times 100$$

$$= \frac{60 + 84}{300} \times 100 = 48\%$$

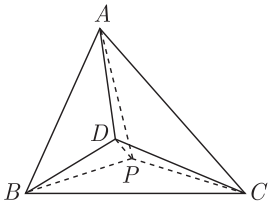
Q. 10 When a point inside of a tetrahedron (a solid with four triangular surfaces) is connected by straight lines to its corners, how many (new) internal planes are created with these lines ? _ _ _ _ _ _ _ _ _ _ _ _ _

Sol. 10 Correct answer is 6.

We draw a tetrahedron structure $ABCD$ as



Now, P is a point inside the tetrahedron.



The point P is connected to each corners A, B, C, D of the tetrahedron. So, we have the internal planes as

$$ABP, APC, BPC, DPC, DPB, DPA$$

i.e the total number of internal planes is 6.

END OF THE QUESTION PAPER

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Electrical Engineering

Q. 1 - Q. 25 Carry one mark each

Q. 1 Given a system of equations

$$x + 2y + 2z = b_1$$
$$5x + y + 3z = b_2$$

What of the following is true regarding its solutions

(A) The system has a unique solution for any given b_1 and b_2

(B) The system will have infinitely many solutions for any given b_1 and b_2

(C) Whether or not a solution exists depends on the given b_1 and b_2

(D) The systems would have no solution for any values of b_1 and b_2

Sol. 1 Correct option is (B).

$$x + 2y + 2z = b_1 \quad \text{...(i)}$$
$$5x + y + 32 = b_2 \quad \text{...(ii)}$$

On eliminating y, we have

$$9x + 4z = 2b_2 - b_1 \quad \{2\times\text{(ii)-(i)}\}$$

Let $b_1 = b_2 = 1$,

$$9x + 4z = 1$$
$$x = \frac{1 - 4z}{9}$$
$$z = \frac{1 - 9x}{4}$$

Hence these will be infinitely many solutions for any given b_1 and b_2.

Q. 2 Let $f(x) = xe^{-x}$. The maximum value of the function in the interval $(0, \infty)$ is

(A) e^{-1} (B) e

(C) $1 - e^{-1}$ (D) $1 + e^{-1}$

Sol. 2 Correct option is (A).

Given the function,

$$f(x) = xe^{-x}$$

To determine the maximum value, we equate the first derivative of function to zero, i.e.

$$f'(x) = e^{-x} + x(-e^{-x}) = e^{-x} - xe^{-x} = 0$$

or $$e^{-x}(1 - x) = 0$$

So, $$x = 1, \infty$$

Again, we check the point of maxima by substituting the obtained values in the second derivative as

$$f''(x) = -e^{-x} + xe^{-x} - e^{-x}$$

At $x = 1$ $$f''(x) = -2e^{-1} + (1)e^{(-1)}$$
$$= -e^{-1} < 0$$

Hence, $f(x)$ is maximum at $x = 1$, and given as

$$f(1) = (1)e^{-1} = e^{-1} \quad \text{at } x = 1$$

Q. 3 The solution for the differential equation

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

$$\frac{d^2x}{dt^2} = -9x$$

with initial conditions $x(0) = 1$ and $\left.\frac{dx}{dt}\right|_{t=0} = 1$, is

(A) $t^2 + t + 1$ (B) $\sin 3t + \frac{1}{3}\cos 3t + \frac{2}{3}$

(C) $\frac{1}{3}\sin 3t + \cos 3t$ (D) $\cos 3t + t$

Sol. 3 Correct option is (C).

Given the differential equation,

$$\frac{d^2x}{dt^2} = -9x$$

Taking the Laplace transform,

$$s^2X(s) - sX(0) - X'(0) = -9X(s)$$

or $$s^2X(s) - s(1) - (1) = -9X(s)$$

or $$X(s)(s^2 + 9) = s + 1$$

or $$X(s) = \frac{s+1}{s^2+9} = \frac{s}{s^2+9} + \frac{1}{s^2+9}$$

or $$X(s) = \frac{s}{s^2+9} + \frac{1}{3}\left(\frac{3}{s^2+9}\right)$$

Again, taking inverse Laplace transform, we obtain

$$x(t) = \cos 3t + \frac{1}{3}\sin 3t$$

ALTERNATIVE METHOD :

Given the differential equation,

$$\frac{d^2x}{dt^2} + 9x = 0$$

Substituting $\frac{d}{dx} \equiv D$, we obtain

or $$D^2 + 9 = 0$$

or $$D = \pm 3i$$

So, the auxiliary equation is written as

$$x = A\cos 3t + iB\sin 3t \quad ...(1)$$

From the given values,

$$x(0) = 1 = A$$

and $$\left.\frac{dx}{dt}\right|_{t=0} = 1 = i3B \Rightarrow B = \frac{1}{3i}$$

Substituting these values in equation (1), we get

$$x = \cos 3t + \frac{1}{3}\sin 3t$$

Q. 4 Let $X(s) = \frac{3s+5}{s^2+10s+21}$ be the Laplace Transform of a signal $x(t)$. Then, $x(0^+)$ is

(A) 0 (B) 3

(C) 5 (D) 21

Sol. 4 Correct option is (B).

Given the Laplace transform,

$$X(s) = \frac{3s+5}{s^2+10s+21}$$

www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

From final value theorem, we know

$$x(t) = \lim_{s \to \infty} sX(s)$$

So, we obtain

$$x(0^+) = \lim_{s \to \infty} sX(0^+)$$

$$= \lim_{s \to \infty} s\left(\frac{3s+5}{s^2+10s+21}\right) = \lim_{s \to \infty} s\,\frac{s\left(3+\frac{5}{s}\right)}{s^2\left(1+\frac{10}{s}+\frac{21}{s^2}\right)}$$

$$= \frac{3+\frac{5}{\infty}}{1+\frac{10}{\infty}+\frac{21}{\infty}} = 3$$

Q. 5 Let S be the set of points in the complex plane corresponding to the unit circle. (That is, $S = \{z : |z| = 1\}$). Consider the function $f(z) = zz^*$ where z^* denotes the complex conjugate of z. The $f(z)$ maps S to which one of the following in the complex plane

(A) unit circle

(B) horizontal axis line segment from origin to (1, 0)

(C) the point (1, 0)

(D) the entire horizontal axis

Sol. 5 Correct option is (C).

Given the set of points in complex plane,

$$S = \{z : |z| = 1\}$$

and the function,

$$f(z) = zz^*$$

By complex number property, we know

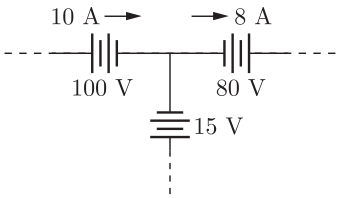
$$zz^* = |z|^2$$

Thus, for the given set of points, i.e. $|z| = 1$; the value of function is

$$f(z) = 1$$

i.e. $f(z)$ maps S to the point (1, 0) on the plane.

Q. 6 The three circuit elements shown in the figure are part of an electric circuit. The total power absorbed by the three circuit elements in watts is _____.



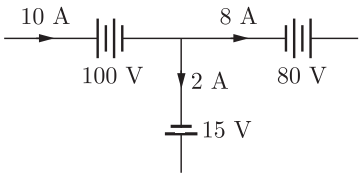
Sol. 6 Correct answer is 330 W.

We redraw the given electric circuit as

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net



From the given circuit, we have the following observations for the connected batteries:

100 V battery: As the current flows through the battery from positive to negative terminal, so it absorbs power.

80 V battery: As the current flows through the battery from negative to positive terminal, so it delivers power.

15 V battery: As the current flows through the battery negative to positive terminal, so it delivers power.

Thus, the net power absorbed by circuit elements is obtained as

$$P_{net} = \text{Power absorbed by 100 V battery} - [\text{Power emitted by 80 V battery} + \text{Power emitted by 15 V battery}]$$

$$= 100 \times 10 - [(80 \times 8) + (15 \times 2)]$$

$$= 1000 - 640 - 30$$

$$= 330 \text{ W}$$

Q. 7 C_0 is the capacitance of a parallel plate capacitor with air as dielectric (as in figure (a)). If, half of the entire gap as shown in figure (b) is filled with a dielectric of permittivity ε_r, the expression for the modified capacitance is

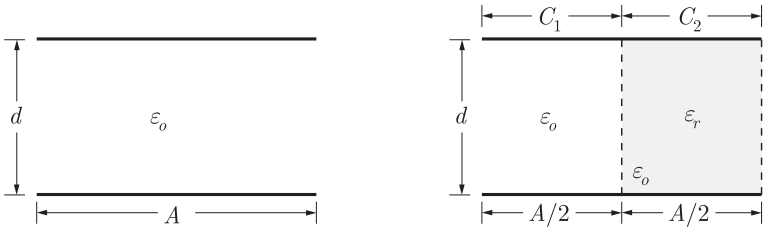
(a) (b)

(A) $\frac{C_0}{2}(1+\varepsilon_r)$ (B) $(C_0+\varepsilon_r)$

(C) $\frac{C_0}{2}\varepsilon_r$ (D) $C_0(1+\varepsilon_r)$

Sol. 7 Correct option is (A).

We redraw the given parallel plate capacitors as



(a) (b)

For the capacitor shown in figure (a), we have

$$C_0 = \frac{\varepsilon_o A}{d} \quad \text{...(i)}$$

where, A = Area of the parallel plate capacitor

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

d = distance between the plates

Again, the capacitor shown in figure (b) can be considered as the two capacitors C_1 and C_2 connected in parallel. So, we have

$$C_1 = \frac{\frac{A}{2}\varepsilon_o}{d}$$

and

$$C_2 = \frac{\frac{A}{2}\varepsilon_o\varepsilon_r}{d}$$

Therefore, we get the net capacitance as

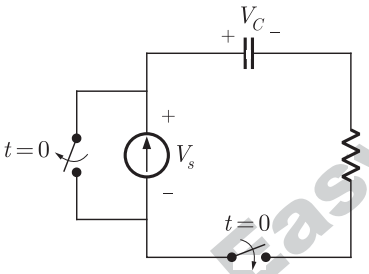
$$C_{net} = C_1 + C_2$$

$$= \frac{A\varepsilon_o/2}{d} + \frac{A\varepsilon_o\varepsilon_r/2}{d} = \frac{A\varepsilon_o}{2d} + \frac{A\varepsilon_o\varepsilon_r}{2d} = \frac{A\varepsilon_o}{2d}(1+\varepsilon_r) \quad ...(ii)$$

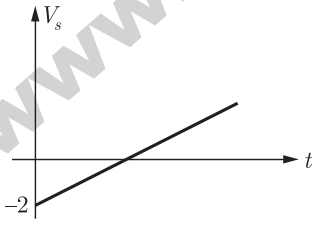
Thus, from equations (i) and (ii), we get

$$C_{net} = \frac{C_o}{2}(1+\varepsilon_r)$$

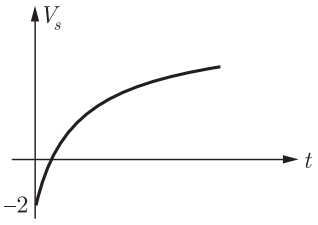
Q. 8 A combination of $1\,\mu F$ capacitor with an initial voltage $v_c(0) = -2\,V$ in series with a $100\,\Omega$ resistor is connected to a $20\,mA$ ideal dc current source by operating both switches at $t = 0\,s$ as shown. Which of the following graphs shown in the options approximates the voltage v_s across the current source over the next few seconds ?



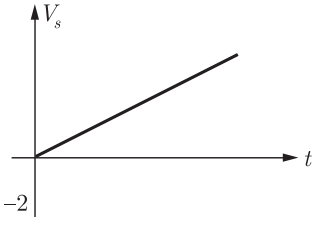
(A)



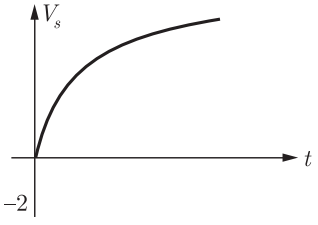
(B)



(C)



(D)



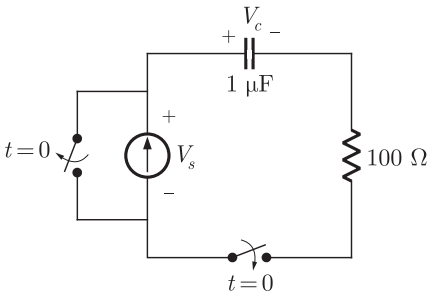
Sol. 8 Correct answer is (C)

We have the given circuit as

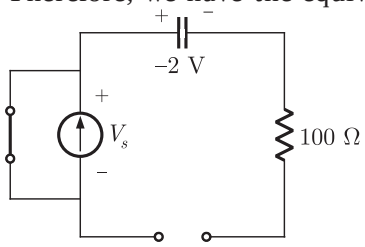
www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net



In the given circuit, the switches operates as shown by the respective arrows. So, at $t = 0$,
Switch 1 (switch across V_s) changes it state from short circuit to open circuit.
Switch 2 changes it state from open circuit to short circuit.
Therefore, we have the equivalent circuit at $t = 0^-$ as (given $V_c(0) = -2\,\text{V}$)



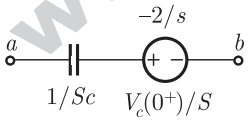
So, from the circuit, we get

$$V_s = 0\,\text{V}\big|_{t=0^-}$$

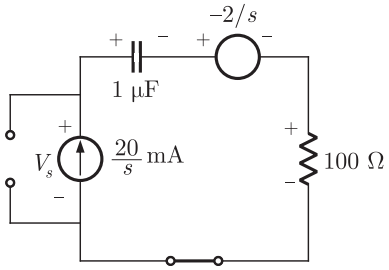
Again, we consider the circuit for $t = 0^+$. By s-domain analysis, we have the equivalent voltage across capacitor as

$$V(s) = \frac{I(s)}{Sc} + \frac{V_c(0^+)}{S}$$

So, we draw the equivalent circuit for given initial voltage across capacitor as



Therefore, we redraw the complete circuit for $t = 0^+$ as



Applying KVL, we get

$$\left(\frac{-2}{5}\right) + \frac{I}{Sc} + 100I = V_s$$

or $$-\frac{2}{s} + \frac{20 \times 10^{-3}}{s} \times \frac{1}{s \times 100^6} + 100 \times \frac{20 \times 10^{-3}}{s} V_s$$

Thus, we obtain

Downloaded From : www.EasyEngineering.net

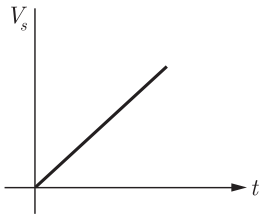
Downloaded From : www.EasyEngineering.net

$$V_s = -\frac{2}{s} + \frac{20 \times 10^3}{s^2} + \frac{2}{s}$$

$$= \frac{2}{s^2} \times 10^4$$

So, $V_s(t) = 2 \times 10^4 t$

i.e. the plot of source voltage is a straight line passing through origin, as shown below.



Q. 9 $x(t)$ is nonzero only for $T_x < t < T_x'$, and similarly, $y(t)$ is nonzero only for $T_y < t < T_y'$. Let $z(t)$ be convolution of $x(t)$ and $y(t)$. Which one of the following statements is TRUE ?

(A) $z(t)$ can be nonzero over an unbounded interval.

(B) $z(t)$ is nonzero for $t < T_x + T_y$

(C) $z(t)$ is zero outside of $T_x + T_y < t < T_x' + T_y'$

(D) $z(t)$ is nonzero for $t > T_x' + T_y'$

Sol. 9 Correct option is (C).

Given the functions,

$$x(t) \neq 0; T_n < t < T_x'$$

and $$y(t) \neq 0; T_y < t < T_y'$$

$z(t)$ is the convolution of $x(t)$ and $y(t)$, i.e.

$$z(t) = x(t) * y(t)$$

So, by convolution theorem, we have

$$z(t) = 0; \quad t < T_x + T_y; t > T_x' + T_y'$$

or $$z(t) = 0; \text{ out side of } \; T_x + T_y < T < T_x' + T_y'$$

Q. 10 For a periodic square wave, which one of the following statements is TRUE ?

(A) The Fourier series coefficients do not exist.

(B) The Fourier series coefficients exist but the reconstruction converges at no point.

(C) The Fourier series coefficients exist and the reconstruction converges at most points.

(D) The Fourier series coefficients exist and the reconstruction converges at every point.

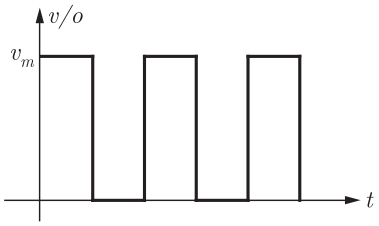
Sol. 10 Correct option is (C).

Consider a periodic square wave shown below.

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net



For the square wave, we observe that the Fourier series coefficients exist and the reconstruction converges at most point.

Q. 11 An 8-pole, 3-phase, 50 Hz induction motor is operating at a speed of 700 rpm. The frequency of the rotor current of the motor in Hz is _ _ _ _ _ _.

Sol. 11 Correct answer is 3.33 Hz.

For the given induction motor, we have

$$P = 8,\ f = 50\ \text{Hz},\ N_r = 700\ \text{rpm}$$

So, we obtain

$$N_s = \frac{120f}{P} = \frac{120 \times 50}{8} = 750\ \text{rpm}$$

Therefore, the slip

$$s = \frac{N_s - N_r}{N_s} = \frac{750 - 700}{750}$$

$$= \frac{1}{15}$$

Thus, the frequency of rotor current of the motor is obtained as

$$\text{Frequency of rotor current} = s \times f$$

$$= \frac{1}{15} \times 50 = 3.33\ \text{Hz}$$

Q. 12 For a specified input voltage and frequency, if the equivalent radius of the core of a transformer is reduced by half, the factor by which the number of turns in the primary should change to maintain the same no load current is

(A) 1/4 (B) 1/2

(C) 2 (D) 4

Sol. 12 Correct option is (D).

EMF equation of Transformer is given by

$$E = \sqrt{2}\,\pi f \phi N$$

where ϕ is the flux density, given as

$$\phi = B \times A$$

Now, the given radius is reduced by half, i.e.

$$r \rightarrow r/2$$

So, the area will be reduced by 1/4, i.e.

$$A \rightarrow A/4$$

To maintain no load current constant [in turn emf (E) to be constant], number of turn should be increased by 4 times.

Q. 13 A star connected 400 V, 50 Hz, 4 pole synchronous machine gave the following open circuit and short circuit test results :

Open circuit test : $V_{oc} = 400$ V (rms, line-to-line) at field current,

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

$I_f = 2.3\,\text{A}$

Short circuit test : $I_{sc} = 10\,\text{A}$ (rms, phase) at field current, $I_f = 1.5\,\text{A}$

The value of per phase synchronous impedance in Ω at rated voltage is_____.

Sol. 13 Correct answer is $15.06\,\Omega$.

For the open circuit test, we have line-to-line voltage at $I_f = 2.3\,\text{A}$ as

$$V_{oc_{L-L}} = 400\,\text{V}$$

So, the open circuit phase voltage is obtained as

$$V_{oc_{ph}} = \frac{400}{\sqrt{3}}\,\text{V}\Big|_{I_g = 2.3\,\text{A}}$$

Again, for short circuit test, we have phase rms current at $I_f = 1.5\,\text{A}$ as

$$I_{sc_{ph}} = 10\,\text{A}\Big|_{I_g = 1.5\,\text{A}}$$

Since I_{sc} and I_f are linearly related, so we get the short circuit phase current at $I_f = 2.3\,\text{A}$ as

$$I'_{sc_{ph}} = \frac{10}{1.5} \times 2.3 = \frac{46}{3}\text{A}\Big|_{I_g = 2.3\,\text{A}}$$

Thus, per phase synchronous impedance is

$$Z_{ph} = \frac{V_{oc_{ph}}}{I'_{sc_{ph}}}\Big|_{I_g = 2.3\,\text{A}}$$

$$= \frac{400/\sqrt{3}}{46/3} = \frac{400 \times \sqrt{3}}{46} = 15.06\,\Omega$$

Q. 14 The undesirable property of an electrical insulating material is

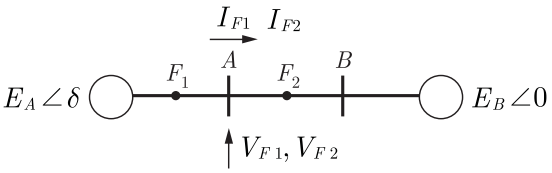
(A) high dielectric strength (B) high relative permittivity

(C) high thermal conductivity (D) high insulation resistivity

Sol. 14 Correct option is (B).

Undesirable property of electrical insulating material is its high relative permittivity (ε_r).

Q. 15 Three-phase to ground fault takes place at locations F_1 and F_2 in the system shown in the figure.



If the fault takes place at location F_1, then the voltage and the current at bus A are V_{F1} and I_{F1} respectively. If the fault takes place at location F_2, then the voltage and the current at bus A and V_{F2} and I_{F2} respectively. The correct statement about voltages and currents during faults at F_1 and F_2 is

(A) V_{F1} leads I_{F1} and V_{F2} leads I_{F2} (B) V_{F1} leads I_{F1} and V_{F2} lags I_{F2}

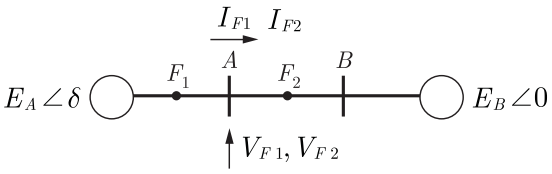
(C) V_{F1} lags I_{F1} and V_{F2} leads I_{F2} (D) V_{F1} lags I_{F1} and V_{F2} lags I_{F2}

Sol. 15 Correct option (C).

We have the given system as

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net



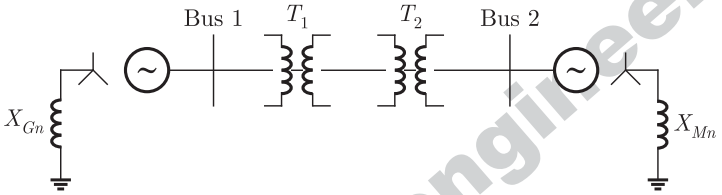
As fault always require/demand reactive power, so voltage should lead current. Using this condition, we have the following observations for the given system:
At fault F_2 which is not near to source require reactive power, hence

V_{F2} leads I_{F2}

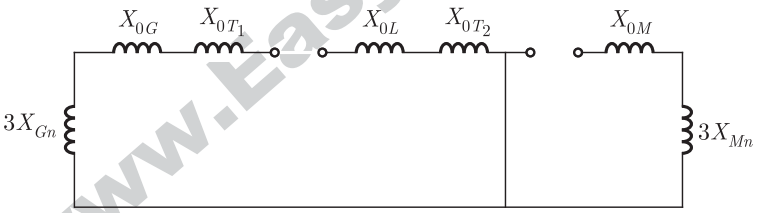
Fault F_1 is near the source, so the current will lead voltage for active requirements, i.e.

V_{F1} lags I_{F1}

Q. 16 A 2-bus system and corresponding zero sequence network are shown in the figure.

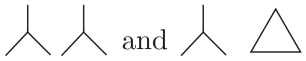


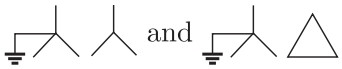
(a)

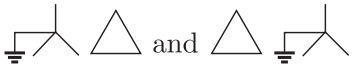


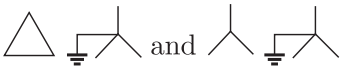
(b)

The transformers T_1 and T_2 are connected as

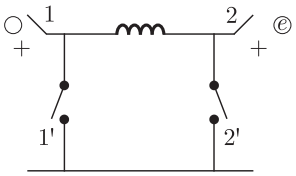
(A)  and

(B)  and

(C)  and

(D)  and

Sol. 16 Correct option is (B).
As the winding and neutral has affect then we represent transformer in zero sequence network using switch diagram.



Switches 1, 1′ → Primary
Switches 2, 2′, → Secondary winding
1, 2 → Series switches

Downloaded From : www.EasyEngineering.net

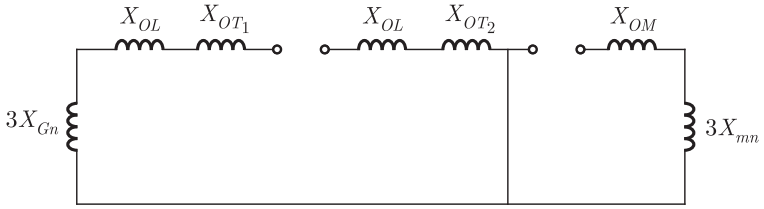
Downloaded From : www.EasyEngineering.net

$1', 2' \rightarrow$ Shunt switches

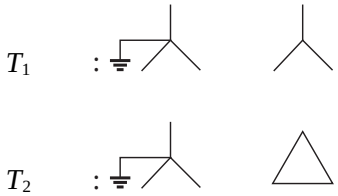
Series switches are closed when transformer is star-connected.

Shunt switches are closed when transformer is delta-connected.

For ground effect $3X_0$.



Here, on T_1 side series switch are closed hence star-connection and grounded due to $3X_{Gn}$. On T_2 side, shunt switches are closed hence one delta and one star with ground.



Q. 17 In the formation of Routh-Hurwitz array for a polynomial, all the elements of a row have zero values. This premature termination of the array indicates the presence of

(A) only one root at the origin (B) imaginary roots

(C) only positive real roots (D) only negative real roots

Sol. 17 Correct option (B).

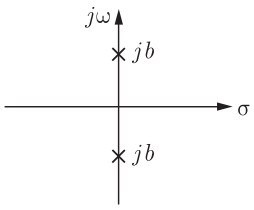
In the given Routh-Hurwitz array of polynomial, all the elements of a row have zero value. This is due to symmetrical location of the roots in the s-plane with respect to origin. The system is either marginally stable or unstable. Now, we check this characteristic for all the given options.

Option (A):

Only one root is at origin. So, it does not satisfy the symmetrical condition.

Option (B):

Since, the system has imaginary roots, so we get the pole-zero location diagram as shown below.



The imaginary roots on $j\omega$ (imaginary) axis are symmetrical with respect to origin. Hence, this option is correct.

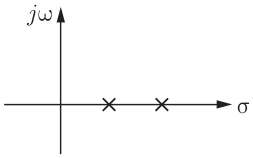
Option (C):

The system has only positive real roots as shown below. So, the root location diagram does not satisfy the symmetrical condition.

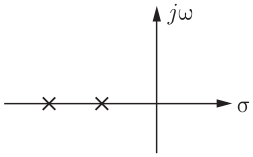
www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

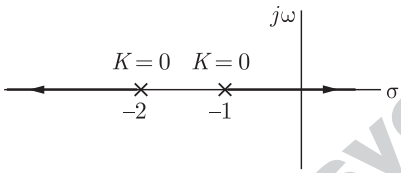
Downloaded From : www.EasyEngineering.net



Option (D):
Again, the system has only negative real roots, as shown below. So, the root location diagram does not satisfy the symmetrical condition.



Q. 18 The root locus of a unity feedback system is shown in the figure.

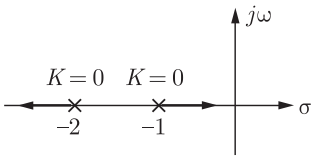


The closed loop transfer function of the system is

(A) $\frac{C(s)}{R(s)} = \frac{K}{(s+1)(s+2)}$ (B) $\frac{C(s)}{R(s)} = \frac{-K}{(s+1)(s+2)+K}$

(C) $\frac{C(s)}{R(s)} = \frac{K}{(s+1)(s+2)-K}$ (D) $\frac{C(s)}{R(s)} = \frac{K}{(s+1)(s+2)+K}$

Sol. 18 Correct option (C).
We have the root locus diagram as



As the root locus have poles $s = -1, -2$ and root lies in even multiple of poles, so it is converse of the main transfer function. Hence, gain should be negative, i.e.

$$G(s)H(s) = \frac{-K}{(s+1)(s+2)}$$

This is open loop transfer function and closed loop transfer function is given by

$$\frac{C(s)}{R(s)} = \frac{G(s)H(s)}{1+G(s)H(s)}$$

$$= \frac{\frac{-K}{(s+1)(s+2)}}{1+\frac{-K}{(s+1)(s+2)}}$$

$$= \frac{-K}{(s+1)(s+2)-K}$$

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Q. 19 Power consumed by a balanced 3-phase, 3-wire load is measured by the two wattmeter method. The first wattmeter reads twice that of the second. Then, the load impedance angle in radians is

(A) $\pi/12$ (B) $\pi/8$

(C) $\pi/6$ (D) $\pi/3$

Sol. 19 Correct option (C).

For two wattmeter method, we define load impedance angle, ϕ as

$$\tan\phi = \sqrt{3}\left[\frac{w_1 - w_2}{w_1 + w_2}\right]$$

where w_1 and w_2 are the readings of two wattmeters. Since, we have

$$w_1 = 2w_2$$

So, we obtain the load impedance angle as

$$\tan\phi = \sqrt{3}\left[\frac{2w_2 - w_2}{2w_2 + w_2}\right]$$

$$= \sqrt{3} \times \frac{1}{3} = \frac{1}{\sqrt{3}}$$

or $$\phi = \frac{\pi}{6}\text{ rad}$$

Q. 20 In an oscilloscope screen, linear sweep is applied at the

(A) vertical axis (B) horizontal axis

(C) origin (D) both horizontal and vertical axis

Sol. 20 Correct option (B).

During sweep time (t_s), the beam moves from left to right across the CRT screen. The beam B deflected to the right by the increasing amplitude of the ramp voltage and the fact that the positive voltage attracts the negative electrons, and to make this effective we apply linear sweep in horizontal axis.

Q. 21 A cascade of three identical modulo-5 counters has an overall modulus of

(A) 5 (B) 25

(C) 125 (D) 625

Sol. 21 Correct option (C).

The cascaded connection of three identical modulo-5 counters is shown below.

Since, overall modulus of cascade of n modulus-5 counters is given by

$$\text{Overall modulas} = 5 \times 5 \times .....n \text{ times}$$

Hence, for the given system, we obtain

$$\text{Overall modulas} = 5 \times 5 \times 5 \qquad (n = 3)$$

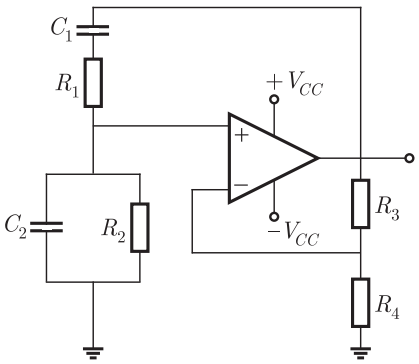
$$= 125$$

Q. 22 In the Wien Bridge oscillator circuit shown in figure, the bridge is balanced when

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

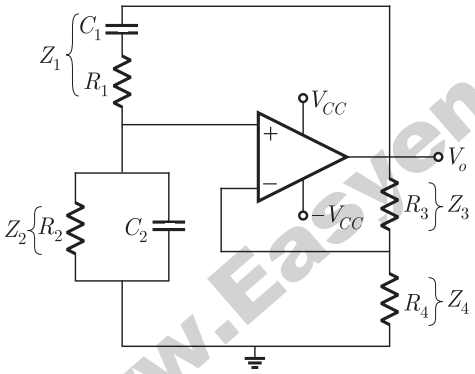


(A) $\frac{R_3}{R_4}=\frac{R_1}{R_2},\ \omega=\frac{1}{\sqrt{R_1C_1R_2C_2}}$ (B) $\frac{R_2}{R_1}=\frac{C_2}{C_1},\ \omega=\frac{1}{R_1C_1R_2C_2}$

(C) $\frac{R_3}{R_4}=\frac{R_1}{R_2}+\frac{C_2}{C_1},\ \omega=\frac{1}{\sqrt{R_1C_1R_2C_2}}$ (D) $\frac{R_3}{R_4}+\frac{R_1}{R_2}=\frac{C_2}{C_1},\ \omega=\frac{1}{R_1C_1R_2C_2}$

Sol. 22 Correct option (C).

To determine the balancing condition, we reconstruct the Wien bridge as



At balance, we have

$$z_1z_4 = z_2z_3$$

or $$\left(R_1-\frac{j}{\omega C_1}\right)R_4=\left(\frac{R_2}{1+j\omega C_2R_2}\right)R_3$$

or $$\frac{R_3}{R_4}=\frac{R_1}{R_2}+\frac{C_2}{C_1}+j\left(\omega C_2R_1-\frac{1}{\omega C_1R_2}\right)$$

Comparing real and imaginary parts, we get

$$\frac{R_3}{R_4}=\frac{R_1}{R_2}+\frac{C_2}{C_1}$$

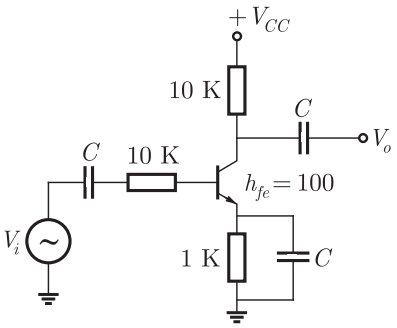
and $$\omega C_2R_1-\frac{1}{\omega C_1R_2}=0\Rightarrow\omega=\frac{1}{\sqrt{R_1C_1R_2C_2}}$$

Q. 23 The magnitude of the mid-band voltage gain of the circuit shown in figure is (assuming h_{fe} of the transistor to be 100)

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

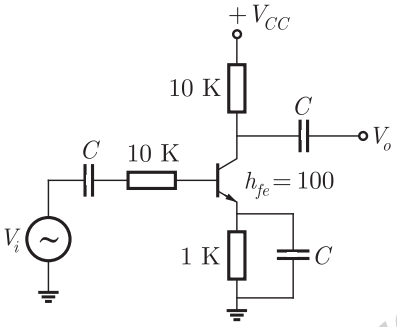


(A) 1 (B) 10

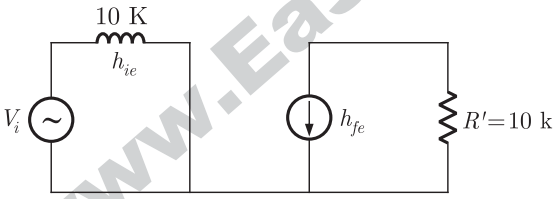
(C) 20 (D) 100

Sol. 23 Correct option (D).

We have the transistor circuit as



Its equivalent h-parameter circuit is drawn as



For the circuit, we obtain the mid-band gain as

$$A_m = \frac{V_o}{V_s}$$

$$= \frac{h_{fe} R'}{R_s + h_{ie}} \qquad (R_s = 0 \text{ as it by passes due to capacitor})$$

$$= \frac{100 \times 10 \times 10^3}{0 + 10 \times 10^3} = 100$$

i.e. the mid-band gain is 100.

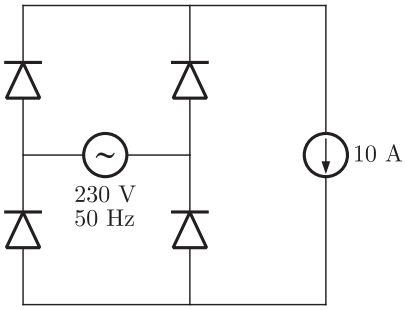
Q. 24 The figure shows the circuit of a rectifier fed from a 230 V (rms), 50 Hz sinusoidal voltage source. If we want to replace the current source with a resistor so that the rms value of the current supplied by the voltage source remains unchanged, the value of the resistance (in ohms) is _ _ _ _ _.

(Assume diodes to be ideal.)

www.Easyengineering.net

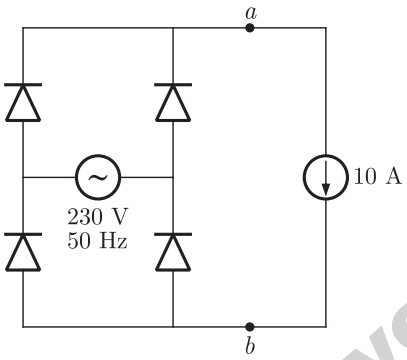
Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net



Sol. 24 Correct answer is 23 ohm.

We have the rectifier circuit as



As the diodes are ideal, so if we are maintaining same current through resistor then V_{ab} also does not change, i.e.

$$V_{ab} = 230 \text{ V}$$

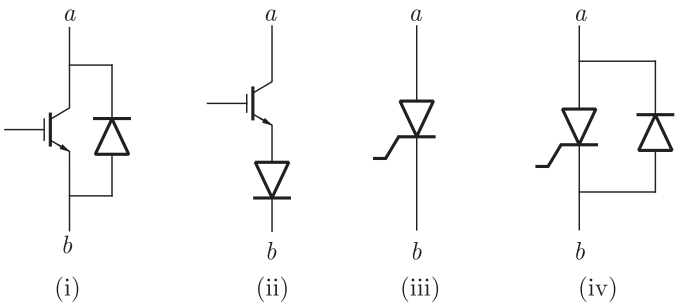
and

$$I_{ab} = 10 \text{ A}$$

Hence, the required value of resistance is

$$R_{ab} = \frac{V_{ab}}{I_{ab}} = \frac{230}{10} = 23\,\Omega$$

Q. 25 Figure shows four electronic switches (i), (ii), (iii) and (iv). Which of the switches can block voltages of either polarity (applied between terminals 'a' and 'b') when the active device is in the OFF state ?



(A) (i), (ii) and (iii)
(B) (ii), (iii) and (iv)
(C) (ii) and (iii)
(D) (i) and (iv)

Sol. 25 Correct option is (C).

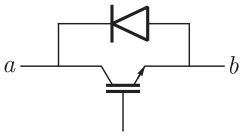
We have to check all the given switches whether it can block voltages of either polarity when the active device is in the OFF state.

Switch (i):

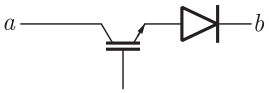
www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

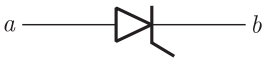
Downloaded From : www.EasyEngineering.net



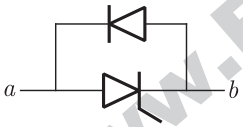
When $V_a > V_b$; diode will be OFF, but the transistor is ON.
When $V_b > V_a$; transistor is OFF, but diode will be ON.
So, the switch can not block voltages of either polarity when the active device (diode or transistor) is in the OFF state.
Switch (ii):



When $V_a > V_b$, both diode and transistor are ON.
When $V_b > V_a$ both diode and transistor are OFF.
So, the switch can block voltages of either polarity when the active devices (diode and transistor) are in the OFF state.
Switch (iii):



When $V_a > V_b$, the SCR is ON.
When $V_b > V_a$, the SCR is OFF.
So, the switch can block voltages of either polarity when the active device (SCR) is in the OFF state.
Switch (iv):



When $V_a > V_b$, diode is OFF.
When $V_b > V_a$, SCR is OFF.
So, the switch can not block voltages of either polarity when the active device (SCR or diode) is in the OFF state.
Thus, the switches (ii) and (iii) only can block voltage of either polarity, when active device is OFF.

Q. 26 - Q. 55 Carry one marks each

Q. 26 Let $g:[0,\infty) \to [0,\infty)$ be a function defined by $g(x) = x - [x]$, where $[x]$ represents the integer part of x. (That is, it is the largest integer which is less than or equal to x).
The value of the constant term in the Fourier series expansion of $g(x)$ is_ _ _ _.

Sol. 26 Correct answer is 0.5.
Given the function,

$$g(x) = x - [x]$$

or

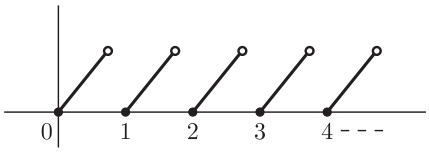
$$g(x) = \{x\}$$

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

So, we have the graph



As this is a periodic function, the constant term will be is average value, i.e.

$$\text{Average value } (a_0) = \frac{1}{T}\int_0^T f(x)dx$$

$$a_0 = \frac{1}{T}\int_0^1 x dx$$

$$= \left[1 \times \frac{x^2}{2}\right]_0^1 = \frac{x^2}{2}\Big|_0^1 = 0.5$$

Hence, the constant term is 0.5

Q. 27 A fair coin is tossed n times. The probability that the difference between the number of heads and tails is $(n-3)$ is

(A) 2^{-n} (B) 0

(C) ${}^nC_{n-3}2^{-n}$ (D) 2^{-n+3}

Sol. 27 Correct option is (B).

Given the fair coin is tossed n times. Assume that

Number of head appearing $= x$ times

Number of tail appearing $= y$ times

So, we have

$$|x-y| = n-3 \qquad \text{(Given)}$$

and $$x+y = n$$

Now, we consider the two cases.

Case I: When $x > y$; we have

$$x - y = n - 3$$

$$\underline{x + y = n}$$

$$2x = 2n - 3$$

So, $$x = \frac{2n-3}{2} = n - \frac{3}{2}$$

As x is an integer and n is also an integer value. So, the above relation is contradictory, and therefore

$$n - \frac{3}{2} \neq x$$

Case II: When $x < y$; we have

$$-x + y = n - 3$$

$$\underline{x + y = n}$$

$$y = n - \frac{3}{2}$$

Again, y is an integer and n is also an integer value. So, the above relation is contradictory.

Thus, the required probability is zero.

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Q. 28 The line integral of function $F = yzi$, in the counterclockwise direction, along the circle $x^2 + y^2 = 1$ at $z = 1$ is

(A) -2π (B) $-\pi$

(C) π (D) 2π

Sol. 28 Correct option is (B).

Given function, $\vec{F} = yz\hat{i}$

and the circle, $x^2 + y^2 = 1$

Now, we have to determine the line integral of $\vec{F}$ along the circle at $z = 1$.

From Green's Theorem, we define line integral as

$$\int \vec{F} \cdot d\vec{l} = \iint \left(\frac{\partial F_y}{\partial x} - \frac{\partial F_x}{\partial y} \right) dxdy \qquad \text{...(i)}$$

where F_x and F_y are components of $\vec{F}$ along x and y directions, respectively, i.e.

$$F_x = yz$$
$$F_y = 0$$

Substituting it in equation (i), we have

$$\int \vec{F} \cdot d\vec{l} = \iint \left[0 - \frac{\partial (yz)}{\partial y} \right] dxdy = -\iint z dxdy$$

At $z = 1$ along the circle, we get

$$\int \vec{F} \cdot d\vec{l} = -\iint 1 \, dxdy$$
$$= -\iint dxdy = -\pi(1)^2 \qquad \text{(area of circle)}$$
$$= -\pi$$

Q. 29 An incandescent lamp is marked 40 W, 240 V. If resistance at room temperature (26°C) is 120 Ω, and temperature coefficient of resistance is $4.8 \times 10^{-3}/°C$, then its 'ON' state filament temperature in °C is approximately _ _ _ _ _.

Sol. 29 Correct answer is 2470.44°C.

For the incandescent lamp, we have

$$P = 40 \text{ W}, V = 240 \text{ V}$$

So, the resistance of its filament in ON state is

$$R_Q = \frac{V^2}{P} = \frac{(240)^2}{40} = 1440 \, \Omega$$

Now, we have

$$R = 120 \, \Omega \quad \text{at } t = 26°C,$$

and $$\alpha = 4.5 \times 10^{-3}/°C$$

Since, the relation between resistance and temperature is given by

$$R_Q = R[1 + \alpha(Q_2 - Q_1)]$$

Substituting the given values, we get

$$1440 = 120\left[1 + 4.5 \times 10^{-3}(Q_2 - 26)\right]$$

or $$12 = 1 + 4.5 \times 10^{-3}(Q_2 - 26)$$

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

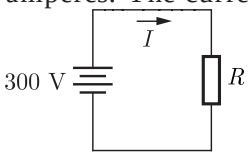
Downloaded From : www.EasyEngineering.net

or $$Q_2 - 26 = \frac{11}{4.5 \times 10^{-3}}$$

or $$Q_2 - 26 = 2.444.44$$

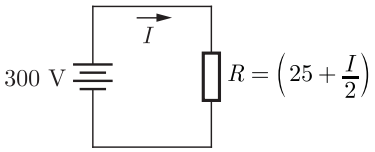
Thus, $$Q_2 = 2470.44^\circ\text{C}$$

Q. 30 In the figure, the value of resistor R is $(25 + I/2)$ ohms, where I is the current in amperes. The current I is _____.



Sol. 30 Correct answer is 10 A.

We redraw the given circuit as



Applying KVL in the circuit, we have

$$300 = IR$$
$$300 = I\left(25 + \frac{I}{2}\right)$$
$$300 = 25I + \frac{I^2}{2}$$
$$I^2 + 50I - 600 = 0$$
$$I^2 + 60I - 10I - 600 = 0$$
$$I(I + 60) - 10(I + 60) = 0$$
$$(I - 10)(I + 60) = 0$$

So, $$I = 10\text{ A}, -60\text{ A}$$

Now, for the two obtained values of current, we get

$$R = \left(25 + \frac{10}{2}\right) = 30$$
$$R = \left(25 - \frac{60}{2}\right) = -5$$ (Resistance can not be negative)

Thus, the current through the circuit is

$$I = 10\text{ A}$$

Q. 31 In an unbalanced three phase system, phase current $I_a = 1(\underline{/-90^\circ})$ pu, negative sequence current $I_{b_2} = 4\underline{/(-150^\circ)}$ pu, zero sequence current $I_{c_0} = 3\underline{/90^\circ}$ pu. The magnitude of phase current I_b in pu is

(A) 1.00 (B) 7.81

(C) 11.53 (D) 13.00

Sol. 31 Correct option is (C).

For the unbalanced three phase system, we have

$$I_{a1} = 1\underline{/-90^\circ}\text{ pu};$$
$$I_{b2} = 4\underline{/-150^\circ}\text{ pu};$$

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

$$I_{c0} = 3\angle 90^\circ \text{ pu}$$

The phase current is given by

$$I_a = I_{a1} + I_{a2} + I_{a0} \quad \text{...(i)}$$

Now, we have

$$I_{b2} = \alpha I_{a2}$$

So, for the given system

$$4\angle -150^\circ = 1\angle 120^\circ I_{a2}$$

or $$I_{a2} = 4\angle -270^\circ$$

Also, we have

$$I_{a0} = I_{b0} = I_{c0} = 3\angle 90^\circ$$

Substituting these values in equation (i), we get

$$I_a = 1\angle -90^\circ = I_{a1} + 4\angle -270^\circ + 3\angle 90^\circ$$

or $$I_{a1} = 1\angle -90^\circ - 4\angle -270^\circ - 3\angle 90^\circ$$
$$= 8\angle -90^\circ$$

So, $$I_{b1} = \alpha^2 I_{a1}$$
$$= 1\angle 240^\circ \times 8\angle -90^\circ = 8\angle 150^\circ$$

Thus, we obtain

$$I_b = I_{b1} + I_{b2} + I_{b0}$$
$$= 8\angle 150^\circ + 4\angle -150^\circ + 3\angle 90^\circ$$
$$= 11.53\angle 154.3^\circ \text{ pu}$$

Q. 32 The following four vector fields are given in Cartesian co-ordinate system. The vector field which does not satisfy the property of magnetic flux density is

(A) $y^2 a_x + z^2 a_y + x^2 a_z$ (B) $z^2 a_x + x^2 a_y + y^2 a_z$

(C) $x^2 a_x + y^2 a_y + z^2 a_z$ (D) $y^2 z^2 a_x + x^2 z^2 a_y + x^2 y^2 a_z$

Sol. 32 Correct option is (C).

According to Maxwell fourth equation

$$\Delta \cdot B = 0$$

i.e. the divergence of magnetic field is zero. Now, we check this property for each of the given vectors.

Option (A):

$$B = y^2 a_x + z^2 a_y + x^2 a_z$$

So, $$\Delta \cdot B = \frac{\partial}{\partial x} y^2 + \frac{\partial}{\partial y} z^2 + \frac{\partial}{\partial z} x^2 = 0$$

Option (B):

$$B = z^2 a_x + x^2 a_y + y^2 a_z$$

So, $$\Delta \cdot B = \frac{\partial}{\partial x} z^2 + \frac{\partial}{\partial y} x^2 + \frac{\partial}{\partial z} y^2 = 0$$

Option (C):

$$B = x^2 a_x + y^2 a_y + z^2 a_z$$

So, $$\Delta \cdot B = \frac{\partial}{\partial x} x^2 + \frac{\partial}{\partial y} y^2 + \frac{\partial}{\partial z} z^2$$
$$= 2x + 2y + 2z \neq 0$$

www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

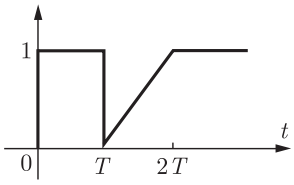
Option (D):

$$B = y^2z^2a_x + x^2z^2a_y + x^2y^2a_z$$

So, $$\Delta \cdot B = \frac{\partial}{\partial x}y^2z^2 + \frac{\partial}{\partial y}x^2z^2 + \frac{\partial}{\partial z}x^2y^2 = 0$$

Thus, the vector given in option (C) does not satisfy the property of magnetic flux density.

Q. 33 The function shown in the figure can be represented as



(A) $u(t) - u(t-T) + \frac{(t-T)}{T}u(t-T) - \frac{(t-2T)}{T}u(t-2T)$

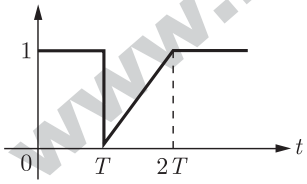
(B) $u(t) + \frac{t}{T}u(t-T) - \frac{t}{T}u(t-2T)$

(C) $u(t) - u(t-T) + \frac{(t-T)}{T}u(t) - \frac{(t-2T)}{T}u(t)$

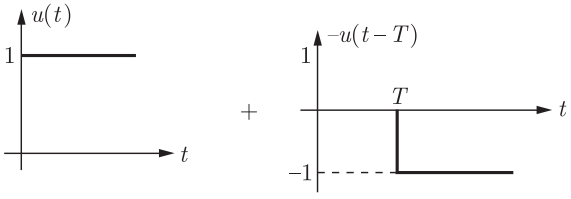
(D) $u(t) + \frac{(t-T)}{T}u(t-T) - 2\frac{(t-2T)}{T}u(t-2T)$

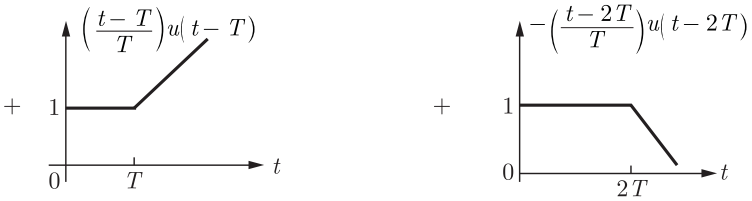
Sol. 33 Correct option is (A).

We have the waveform,



The function represented in the waveform can be resolved in the following four waveforms; where $u(t)$ is the unit step function.



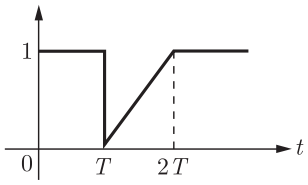


www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

$=$



Thus, the function shown in the waveform is

$$f(t)$$
$$= u(t) - u(t-T) + \frac{(t-T)}{T}u(t-T) - \frac{(t-2T)}{T}u(t-2T)$$

Q. 34 Let $X(z) = \frac{1}{1-z^{-3}}$ be the z-transform of a causal signal $x[n]$.

Then, the values of $x[2]$ and $x[3]$ are

(A) 0 and 0 (B) 0 and 1

(C) 1 and 0 (D) 1 and 1

Sol. 34 Correct option is (B).

Given the z-transform of causal signal $x[n]$ as

$$X(z) = \frac{1}{1-z^{-3}} = 1 + \frac{1}{z^3} + \left(\frac{1}{z^3}\right)^2 + \ldots$$
$$= 1 + \frac{1}{z^3} + \frac{1}{z^6} + \ldots\ldots \quad \ldots(i)$$

Now, the z-transform is defined as

$$X(z) = \sum_{n=0}^{\infty} x[n] z^{-n}$$
$$= x[0] + \frac{x[1]}{z} + \frac{x[2]}{z^2} + \frac{x[3]}{z^3} + \ldots \quad \ldots(ii)$$

Comparing equations (i) and (ii), we get

$$x[0] = 1,\ x[1] = 0$$

$$x[2] = 0,\ x[3] = 1$$

Q. 35 Let $f(t)$ be a continuous time signal and let $F(\omega)$ be its Fourier Transform defined by

$$F(\omega) = \int_{-\infty}^{\infty} f(t) e^{-j\omega t} dt$$

Define $g(t)$ by $$g(t) = \int_{-\infty}^{\infty} F(u) e^{-jut} du$$

What is the relationship between $f(t)$ and $g(t)$?

(A) $g(t)$ would always be proportional to $f(t)$

(B) $g(t)$ would be proportional to $f(t)$ if $f(t)$ is an even function

(C) $g(t)$ would be proportional to $f(t)$ only if $f(t)$ is a sinusoidal function

(D) $g(t)$ would never be proportional to $f(t)$

Sol. 35 Correct option is (B).

Given the Fourier transform pair,

$$F(\omega) = \int_{-\infty}^{\infty} f(t) e^{-j\omega t} dt$$

and the function $g(t)$ is defined as

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

$$g(t) = \int_{-\infty}^{\infty} F(u)e^{-jut}du \qquad ...(i)$$

Again, the inverse Fourier transform of $F(\omega)$ is written as

$$f(t) = \int_{-\infty}^{\infty} F(\omega)e^{j\omega t}d\omega$$

Replacing t by $-t$ and ω by u in above expression, we get

$$f(-t) = \int_{-\infty}^{\infty} F(u)e^{-jut}du \qquad ...(ii)$$

Thus, by comparing equations (i) and (ii), we have

$$g(t) = f(-t)$$

If $f(t)$ be an even function, then

$$f(-t) = f(t)$$

which in turn gives

$$g(t) = f(t)$$

i.e. $g(t)$ will be proportional to $f(t)$, if $f(t)$ is an even function.

Q. 36 The core loss of a single phase, 230/115 V, 50 Hz power transformer is measured from 230 V side by feeding the primary (230 V side) from a variable voltage variable frequency source while keeping the secondary open circuited. The core loss is measured to be 1050 W for 230 V, 50 Hz input. The core loss is again measured to be 500 W for 138 V, 30 Hz input. The hysteresis and eddy current losses of the transformer for 230 V, 50 Hz input are respectively,

(A) 508 W and 542 W (B) 468 W and 582 W

(C) 498 W and 552 W (D) 488 W and 562 W

Sol. 36 Correct option is (A).

For $V = 230$ V and $f = 50$ Hz, we have

$$\text{Core loss} = 1050 \text{ W}$$

or $$\text{Iron loss} + \text{Hysteresis loss} = 1050 \text{ W} \qquad ...(i)$$

Since, iron loss and hysteresis loss are given by

$$\text{Iron loss} = P_i = k_i V^2$$

and $$\text{Hysteresis loss} = P_H = K_H V^{1.6} f^{-0.6}$$

Substituting it in equation (i), we get

$$K_i(230)^2 + K_H \frac{(230)^{1.6}}{(50)^{0.6}} = 1050$$

or $$K_i(52900) + K_H(574.62) = 1050 \qquad ...(ii)$$

Again, for $V = 138$ V and $f = 30$ Hz, we have

$$\text{Core loss} = 500 \text{ W}$$

or $$\text{Iron loss} + \text{Hysteresis loss} = 500 \text{ W}$$

or $$K_P(138)^2 + K_H \frac{(138)^{1.6}}{(30)^{0.6}} = 500$$

or $$K_P(19044) + K_H(344.77) = 500 \qquad ...(ii)$$

Solving equations (i) and (ii), we get

$$K_P = 0.01024$$

and $$K_H = 0.855$$

For 230 V, 50 Hz; we have

www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

$$\text{Hysteresis loss} = K_H V^{1.6} f^{-0.6}$$
$$= 0.855 \times (230)^{1.6} \times (50)^{-0.6}$$
$$= 508.53 \text{ W}$$

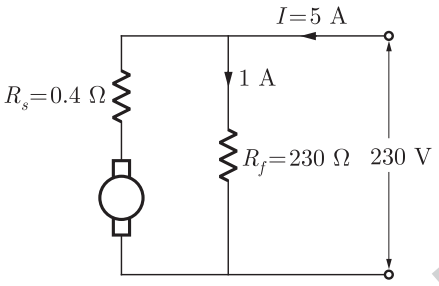
Hence, the eddy loss is

$$\text{Eddy loss} = K_{IV^2} = 0.01024 \times 52900$$
$$= 541.69 \text{ W}$$

Q. 37 A 15 kW, 230 V dc shunt motor has armature circuit resistance of $0.4\,\Omega$ and field circuit resistance of $230\,\Omega$. At no load and rated voltage, the motor runs at 1400 rpm and the line current drawn by the motor is 5 A. At full load, the motor draws a line current of 70 A. Neglect armature reaction. The full load speed of the motor in rpm is_____.

Sol. 37 Correct answer is 1241. rpm.

For the given data, we draw the circuit as



So, the current through field resistance is

$$I_f = \frac{V}{R_f} = \frac{230}{230} = 1 \text{ A}$$

Hence, we have the armature current,

$$I_a = I - I_f$$
$$= 5 - 1 = 4 \text{ A}$$

From the given circuit, we have

$$V = E_{f1} + I_a \times R_s$$

or $$230 = E_{f1} + 4 \times 0.4$$

or $$E_{f1} = 228.4 \text{ V}$$

At full load,

$$I = 70 \text{ A}$$

So, $$I_a = 70 - 1 = 69 \text{ A}$$

and $$E_{f2} = 230 - 69 \times 0.4$$
$$= 202.4 \text{ V}$$

as $$\text{emf} \propto \text{flux} \times \text{speed}$$

For DC shunt motor flux (ϕ) is constant. So,

$$E_f \propto \omega$$

or $$\frac{E_{f1}}{E_{f2}} = \frac{\omega_1}{\omega_2}$$

or $$\frac{228.4}{202.4} = \frac{1400}{\omega_2}$$

Thus, $$\omega_2 = \frac{202.4}{228.4} \times 1400 = 1241.1 \text{ rpm}$$

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Q. 38 A 3 phase, 50 Hz, six pole induction motor has a rotor resistance of $0.1\,\Omega$ and reactance of $0.92\,\Omega$. Neglect the voltage drop in stator and assume that the rotor resistance is constant. Given that the full load slip is 3%, the ratio of maximum torque to full load torque is

(A) 1.567 (B) 1.712

(C) 1.948 (D) 2.134

Sol. 38 Correct option is (C).

For the induction motor, we have

$$T_f \text{ (Full load torque)} \propto \frac{s_f R_2}{R_2^2 + (s_f X_2)^2}$$

or $$T_{\max} (\max^m \text{ torque}) \propto \frac{1}{2X_2}$$

So, we get

$$\frac{T_f}{T_{\max}} = \frac{2 s_f R_2 X_2}{R_2^2 + (s_f X_2)^2}$$

or $$\frac{T_f}{T_{\max}} = \frac{2}{\frac{s_{\max}}{s_f} + \frac{s_f}{s_{\max}}} \quad \text{...(i)}$$

Now, the slip at full load is 3%, i.e.

$$s_f = 0.003$$

and $$s_{\max} = \frac{R_2}{X_2} = \frac{0.1}{0.92} = 0.108$$

Substituting these values in equation (i), we get

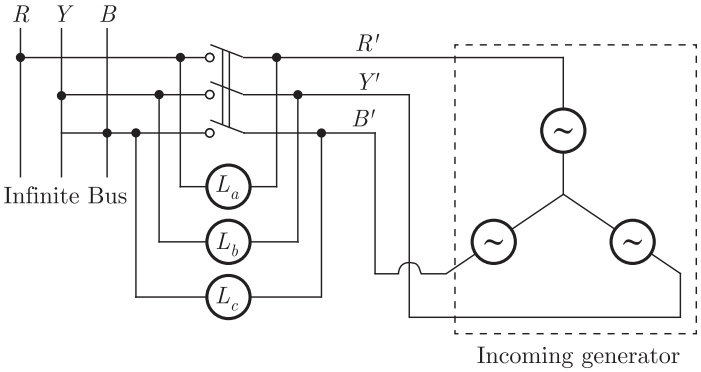
$$\frac{T_f}{T_{\max}} = \frac{2}{\frac{0.108}{0.03} + \frac{0.03}{0.108}}$$

or $$\frac{T_{\max}}{T_f} = \frac{3.623 + 0.276}{2}$$

or $$\frac{T_{\max}}{T_f} = 1.948$$

i.e. the ratio of maximum torque to full load torque is 1.948.

Q. 39 A three phase synchronous generator is to be connected to the infinite bus. The lamps are connected as shown in the figure for the synchronization. The phase sequence of bus voltage is R-Y-B and that of incoming generator voltage is R′ - Y′ - B′.



Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

It was found that the lamps are becoming dark in the sequence $L_a - L_b - L_c$. It means that the phase sequence of incoming generator is

(A) opposite to infinite bus and its frequency is more than infinite bus

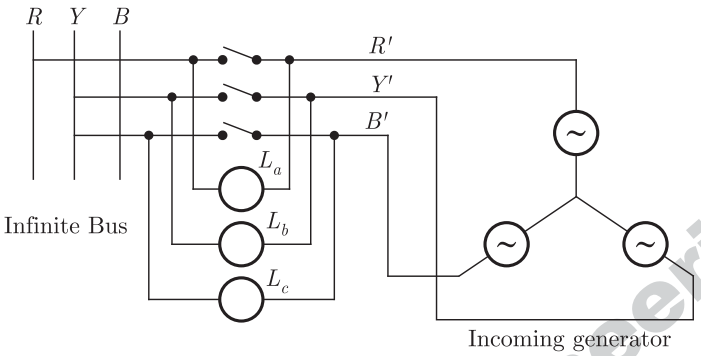
(B) opposite to infinite bus but its frequency is less than infinite bus

(C) same as infinite bus and its frequency is more than infinite bus

(D) same as infinite bus and its frequency is less than infinite bus

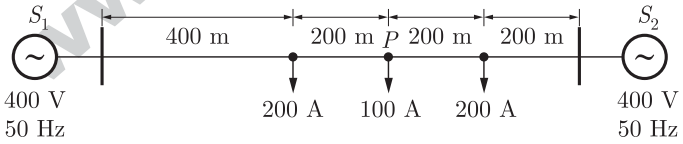
Sol. 39 Correct option is (A).

Given the three phase synchronous generator,



If all the bulbs glow dark simultaneously, then all the gear and infinite bus are in same phase sequence. But, in the given problem, they are coming in sequence (not simultaneously) L_a then L_b, and then L_c. So, phase sequence of the generator is opposite to infinite bus system and frequency is high (as dark period is for more time).

Q. 40 A distribution feeder of 1 km length having resistance, but negligible reactance, is fed from both the ends by 400 V, 50 Hz balanced sources. Both voltage sources S_1 and S_2 are in phase. The feeder supplies concentrated loads of unity power factor as shown in the figure.



The contributions of S_1 and S_2 in 100 A current supplied at location P respectively, are

(A) 75 A and 25 A

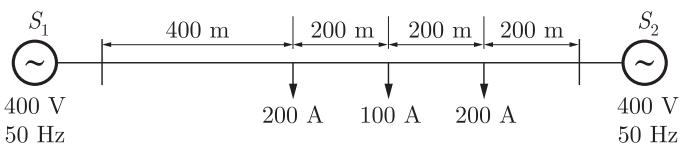
(B) 50 A and 50 A

(C) 25 A and 75 A

(D) 0 A and 100 A

Sol. 40 Correct option is (D).

We have the distribution feeder as



Let current I be supplied by source (s_1), and r be the resistance per unit length. Applying KVL, we get

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

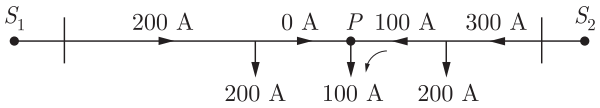
$$400-(r\times 400)I-(200r)(I-200)-(200r)(I-300)-(200r)(I-500)$$
$$=400$$

or $$400Ir+200Ir-40000r+200Ir-60000r+200Ir-100000r=0$$

or $$1000Ir=200000r$$

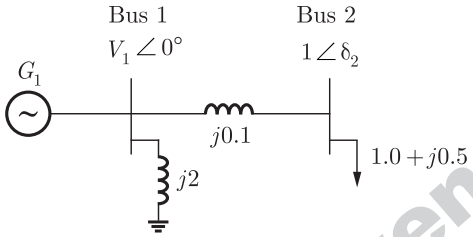
So, $$I=200\text{ A}$$

So, we redraw the current in distribution system as



Thus, the contribution of source (s_1) in 100 A load at P is 0 A, and the contribution of s_2 in 100 A load at P is 100 A.

Q. 41 A two bus power system shown in the figure supplies load of $1.0+j0.5$ p.u.



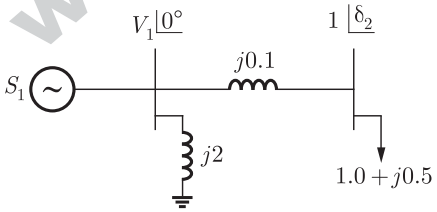
The values of V_1 in p.u. and δ_2 respectively are

(A) 0.95 and 6.00° (B) 1.05 and −5.44°

(C) 1.1 and −6.00° (D) 1.1 and −27.12°

Sol. 41 Correct option is (B).

Given the two bus power system,



Now, the current through impedance Z is given by

$$I=\frac{V_1-V_2}{Z}$$

For the given system, we have

$$V_1=V_1\angle 0°;\ V_2=1\angle\delta_2,\ z=0.1\angle 90°$$

So, we obtain the current

$$I\angle\theta=\frac{V_1\angle 0°-1\angle\delta_2}{0.1\angle 90°}=1+j0.5$$

or $$V_1\angle 0°-1\angle\delta_2=0.11\angle 116.56$$

or $$V_1-(\cos\delta_2-j\sin\delta_2)=0.11[\cos 116.56°+j\sin 116.36°]$$

Comparing the real and imaginary terms, we get

$$-\sin\delta_2=0.11\times\sin 116.36°$$

or $$-\sin\delta_2=0.098$$

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

or $\delta_2 = -5.65^\circ$

Also, $V_1 - \cos\delta_2 = 0.11\cos 116.56^\circ$

or $V_1 = 1.05$

Q. 42 The fuel cost functions of two power plants are

Plant P_1: $C_1 = 0.05Pg_1^2 + APg_1 + B$

Plant P_2: $C_2 = 0.10Pg_2^2 + 3APg_2 + 2B$

where, P_{g1} and P_{g2} are the generated powers of two plants, and A and B are the constants. If the two plants optimally share 1000 MW load at incremental fuel cost of 100 Rs/MWh, the ratio of load shared by plants P_1 and P_2 is

(A) 1 : 4 (B) 2 : 3

(C) 3 : 2 (D) 4 : 1

Sol. 42 Correct option is (D).

The fuel cost functions for plant P_1 and P_2 are

$$C_1 = 0.05P_{g_1^2} + AP_{g_1} + B \quad ...(i)$$

$$C_2 = 0.10P_{g_2^2} + 3AP_{g_2} + 2B \quad ...(ii)$$

Given $P_{g_1} + P_{g_2} = 1000\,\text{MW}$ ...(iii)

and $\dfrac{dC_1}{dP_{g_1}} = \dfrac{dC_2}{dP_{g_2}} = 100$ ...(iv)

Also, from equations (i) and (ii), we have

$$\frac{dC_1}{dP_{g_1}} = 2 \times 0.05P_{g_1} + A$$

$$\frac{dC_2}{dP_{g_2}} = 2 \times 0.10P_{g_2} + 3A$$

Substituting equation (iii) in above expressions, we get

$$0.1P_{g_1} + A = 100$$

$$0.2P_{g_2} + 3A = 100$$

$$0.3P_{g_1} - 0.2P_{g_2} = 200 \quad ...(v)$$

Hence, solving the equations (iii) and (v), we obtain

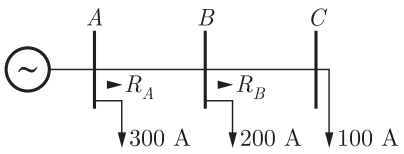
$$P_{g_1} = 800\,\text{MW}$$

and $P_{g_2} = 200\,\text{MW}$

Therefore, the ratio of load shared by plants P_1 and P_2 is

$$\frac{P_{g_1}}{P_{g_2}} = \frac{800}{200} = \frac{4}{1}$$

Q. 43 The over current relays for the line protection and loads connected at the buses are shown in the figure.



The relays are IDMT in nature having the characteristic

$$t_{op} = \frac{0.14 \times \text{Time Multiplier Setting}}{(\text{Plug Setting Multiplier})^{0.02} - 1}$$

The maximum and minimum fault currents at bus B are 2000 A and 500 A respectively. Assuming the time multiplier setting and plug setting for relay R_B to be 0.1 and 5 A respectively, the operating time of R_B (in seconds) is_____.

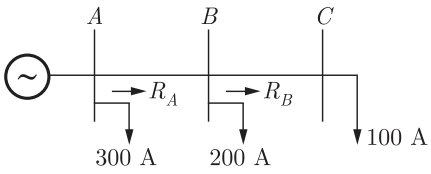
www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Sol. 43 Correct answer is 0.226.

We have the circuit,



The operating time of relays is given as

$$t_{op} = \frac{0.14 \times \text{Time multiplier setting (TMS)}}{(\text{plug setting multiplier})^{0.02} - 1} \quad \text{...(i)}$$

For relay R_B, we have

$$TMS = 0.1$$

$$PSM = \frac{\text{maximum fault current}}{CT\ ratio}$$

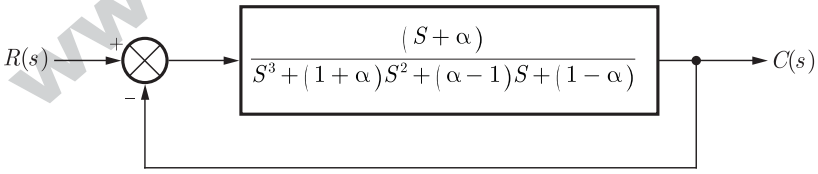
$$= \frac{2000}{500/5} = 20$$

Substituting the values in equation (i), we get

$$t_{op} = \frac{0.14 \times 0.1}{(20)^{0.02} - 1} = \frac{0.14 \times 0.1}{0.617}$$

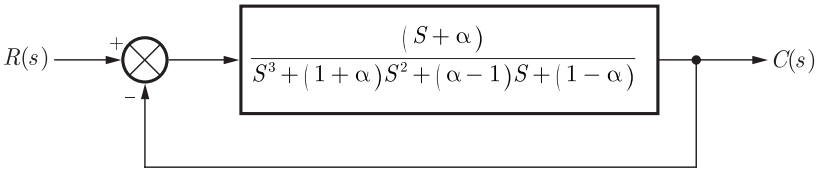
$$= 0.226$$

Q. 44 For the given system, it is desired that the system be stable. The minimum value of α for this condition is _____.



Sol. 44 Correct answer is 0.618.

The Block diagram of given system is



The open loop transfer function is

$$G(s)H(s) = \frac{(s+\alpha)}{s^3+(1+\alpha)s^2+(\alpha-1)s+(1-\alpha)}$$

So, we obtain the character equation as

$$1 + G(s)H(s) = 0$$

or

$$1 + \frac{(s+\alpha)}{s^3+(1+\alpha)s^2+(\alpha-1)s+(1-\alpha)} = 0$$

www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

or $$s^3+(1+\alpha)s^2+(\alpha-1)s+(1-\alpha)+(s+\alpha)=0$$

or $$s^3+(1+\alpha)s^2+(\alpha-1+1)s+1-\alpha+\alpha=0$$

or $$s^3+(1+\alpha)s^2+\alpha s+1=0$$

For the characteristic equation, we form the Routh's array as

$$\begin{array}{c|cc} s^3 & 1 & \alpha \\ s^2 & 1+\alpha & 1 \\ s^1 & \dfrac{\alpha(1+\alpha)-1}{1+\alpha} & 0 \\ s^0 & 1 & \end{array}$$

For stable system, the required condition is

$$1+\alpha>0$$

or $$\alpha>-1$$

or $$\frac{\alpha(1+\alpha)-1}{1+\alpha}>0$$

or $$\alpha(1+\alpha)-1>0$$

Solving the inequality, we obtain the roots

$$\alpha=\frac{-1-\sqrt{5}}{2},\frac{-1+\sqrt{5}}{2}$$

So, we get the result for inequality as

$$\alpha>0.618 \text{ and } \alpha<-1.62$$

i.e. the minimum value of α is

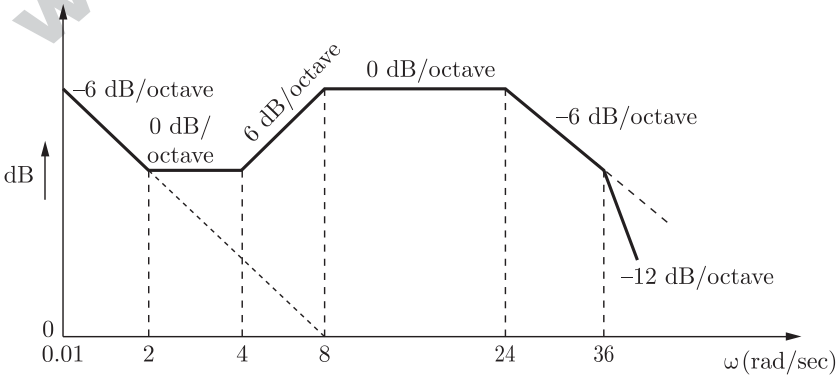
$$\alpha=0.618$$

Q. 45 The Bode magnitude plot of the transfer function

$$G(s)=\frac{K(1+0.5s)(1+as)}{s\left(1+\frac{s}{8}\right)(1+bs)\left(1+\frac{s}{36}\right)}$$

is shown below :

Note that $-6\,\text{dB/octave}=-20\,\text{dB/decade}$. The value of $\frac{a}{bK}$ is _____.

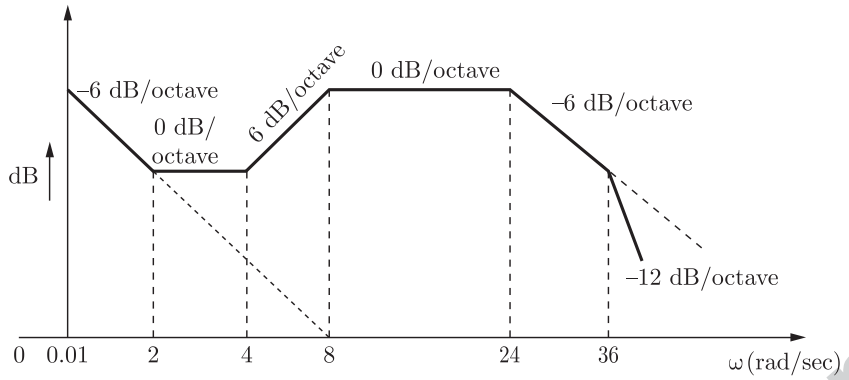


Sol. 45 Correct answer is 0.75.

Given the Bode magnitude plot of the transfer function,

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net



Also, from the given transfer function, we have

$$G(s) = \frac{K(1+0.55)(1+as)}{s\left(1+\frac{s}{8}\right)(1+bs)\left(1+\frac{s}{36}\right)}$$

$$= \frac{K(1-s/2)(1+s/\frac{1}{a})}{s\left(1+\frac{s}{8}\right)\left(1+\frac{s}{1/b}\right)\left(1+\frac{s}{36}\right)}$$

The first slope $-6\,\text{dB/octave}$ is due to one pole that is $1/s$
Then, slope 0 dB/octave is due to addition of a zero in T.F. $(1+s/2)$.
Again, $+6\,\text{dB/octave}$ slope is due to one zero at corner frequency $\omega_C = 4$. Comparing it to the transfer function, we get

$$(1+as) = (1+s/4)$$

or $$a = 1/4$$

Similarly, at $\omega_C = 24$, there is an addition of a pole $(-6\,\text{dB/octave})$. So, we get

$$(1+bs) = (1+s/24)$$

or $$b = \frac{1}{24}$$

From the shown Bode plot, we observe that if we extended the slope $-6\,\text{dB/octave}$, it meets the frequency axis at $\omega_C = 8$. So, we have

$$0 = 20\log\left|\frac{KX}{s}\right|_{\omega_C=8}$$

or $$1 = \frac{K}{8}$$

or $$K = 8$$

Therefore, we obtain the desired value as

$$\frac{a}{bK} = \frac{1/4}{\frac{1}{24}\times 8} = \frac{24}{4\times 8} = 0.75$$

Q. 46 A system matrix is given as follows

$$A = \begin{bmatrix} 0 & 1 & -1 \\ -6 & -11 & 6 \\ -6 & -11 & 5 \end{bmatrix}$$

The absolute value of the ratio of the maximum eigenvalue to the minimum eigenvalue is _ _ _ _ _ _ _.

Sol. 46 Correct answer is 3.
Given the system matrix,

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

$$A = \begin{bmatrix} 0 & 1 & -1 \\ -6 & -11 & 6 \\ -6 & -11 & 5 \end{bmatrix}$$

The Eigen values for the system matrix is given by the roots of the equation

$$|A - \lambda I| = 0$$

or $$\left| \begin{bmatrix} 0 & 1 & -1 \\ -6 & -11 & 6 \\ -6 & -11 & 5 \end{bmatrix} - \begin{bmatrix} \lambda & 0 & 0 \\ 0 & \lambda & 0 \\ 0 & 0 & \lambda \end{bmatrix} \right| = 0$$

or $$= \begin{vmatrix} -\lambda & 1 & -1 \\ -6 & -11-\lambda & 6 \\ -6 & -11 & 5-\lambda \end{vmatrix} = 0$$

or $$[-\lambda(-55 - 5\lambda + 11\lambda + \lambda^2 + 66)$$
$$+1(-36 + 30 - 6\lambda) - 1(66 - 66 - 6\lambda) = 0$$

or $$(-\lambda^3 - 6\lambda^2 - 11\lambda) - 6 - 6\lambda + 6\lambda = 0$$

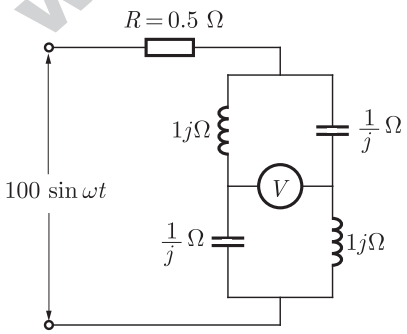
or $$\lambda^3 + 6\lambda^2 + 11\lambda + 6 = 0$$

So, $$\lambda = -1, -2, -3$$

Thus, the ratio of maximum eigenvalue to minimum eigenvalue is

$$\left| \frac{\lambda_{max}}{\lambda_{min}} \right| = \left| \frac{-3}{-1} \right| = 3$$

Q. 47 The reading of the voltmeter (rms) in volts, for the circuit shown in the figure is



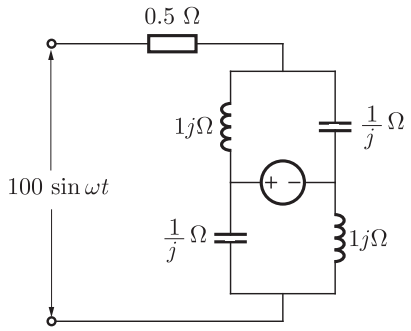
Sol. 47 Correct answer is 141.42 V.

We have the circuit,

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net



It is a Wheatstone bridge. For the bridge to be balanced, the required condition is

$$z_1 z_4 = z_2 z_3 \qquad \text{...(i)}$$

From the given circuit, we have

$$z_1 = z_4 = j\,1\,\Omega$$

and

$$z_2 = z_3 = \frac{1}{j}\Omega$$

Substituting these values in equation (i), we get

$$j \times j = \frac{1}{j} \times \frac{1}{j}$$

$$j^2 = \frac{1}{j^2}$$

$$-1 = -1$$

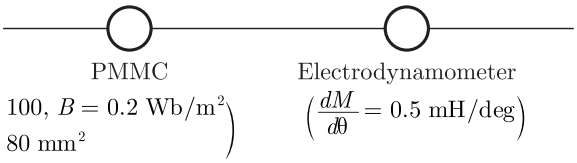
Hence, it is a balanced Wheatstone bridge, and reading of voltmeter (rms) is

$$V = 100 \times \sqrt{2}$$
$$= 141.42 \text{ V}$$

Q. 48 The dc current flowing in a circuit is measured by two ammeters, one PMMC and another electrodynamometer type, connected in series. The PMMC meter contains 100 turns in the coil, the flux density in the air gap is $0.2\ \text{Wb/m}^2$, and the area of the coil is $80\ \text{mm}^2$. The electrodynamometer ammeter has a change in mutual inductance with respect to deflection of 0.5 mH/deg. The spring constants of both the meters are equal. The value of current, at which the deflections of the two meters are same, is _ _ _ _ _ _

Sol. 48 Correct answer is 3.2 A.

Given that the two ammeters, one PMMC and another electrodynamometer type, are connected in series. So, we have



For PMMC coil, we define the deflecting torque as

$$\tau_d = NBAI$$
$$= GI \qquad \text{...(i)}$$

where G is a constant, given as

$$G = NBA$$

Again, the controlling torque is defined as

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

$$T_c = K\,\theta \qquad \text{...(ii)}$$

At balance, we have

$$T_c = T_d$$

So, deflection $\theta = \frac{G}{K} I$ [using equations (i) and (ii)] ...(iii)

Now, for electrodynamometer, we have deflecting torque

$$T_d = I_1 I_2 \frac{dM}{d\theta}$$

where $I_1 = I_2 = I$ (series)

So, $$T_d = I^2 \frac{dM}{d\theta} \qquad \text{...(iv)}$$

The controlling torque is

$$T_c = K\theta \qquad \text{...(v)}$$

Therefore, equating the equations (iv) and (v) for balance condtion, the steady deflection is obtained as

$$\theta = \frac{I^2}{K}\frac{dM}{d\theta} \qquad \text{...(vi)}$$

Since, it is given in the question that deflection is same in both meter. So, from equations (iii) and (vi), we get

$$\frac{G}{K} I = \frac{I^2}{K}\frac{dM}{d\theta}$$

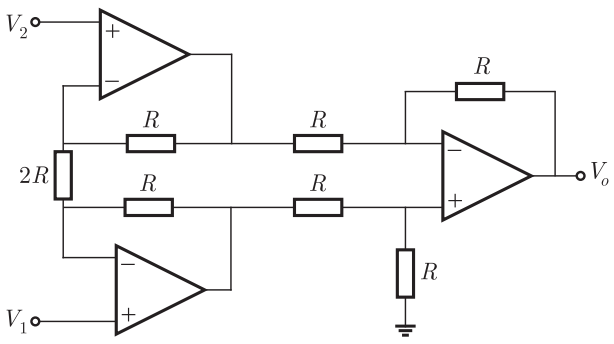
or $$NBA = I\frac{dM}{d\theta}$$ (spring constants are equal)

or $$100 \times 0.2 \times 80 \times 10^{-6} = I \times 0.5 \times 10^{-3}$$

Thus, $$I = \frac{100 \times 2 \times 80 \times 10^{-3}}{5} = 3.2 \text{ A}$$

www.EasyEngineering.net

Q. 49 Given that the op-amps in the figure are ideal, the output voltage V_0 is



(A) $(V_1 - V_2)$ (B) $2(V_1 - V_2)$

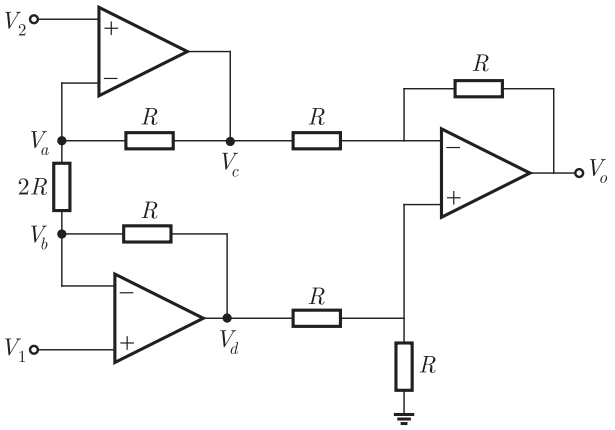
(C) $(V_1 - V_2)/2$ (D) $(V_1 + V_2)$

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Sol. 49 Correct option is (B).

We redraw the given op-amp circuit as



Node voltage V_c is connected to inverting mode of op-amp. So, we have the output due to V_c as

$$V_o^+ = \frac{R_f}{R_1} V_1 = -\frac{R}{R} V_c$$

Again, node voltage V_d is connected to the non-inverting mode of op-amp. So, we have the output due to V_d as

$$V_o^- = +\left(1+\frac{R_f}{R_1}\right)\frac{R_f}{2R_1}\ V_2 = \left(1+\frac{R}{R}\right)\frac{R}{2R} V_d$$

Therefore, the net output of the op-amp is

$$\begin{aligned} V_o &= V_o^+ + V_o^- \\ &= -V_c \times \left(\frac{R}{R}\right) + V_d \frac{R}{2R}\left(1+\frac{R}{R}\right) \\ &= -V_c + \frac{V_d}{2} \times 2 = V_d - V_c \end{aligned} \quad \text{...(i)}$$

Applying KVL in the op-amp circuit, we have

$$-V_c + IR + I(2R) + IR + V_d = 0$$

or $$V_d - V_c = -4IR$$

or $$V_o = -4IR \quad \text{[using equation (i)]} \quad \text{...(ii)}$$

Also, we have

$$-V_a + 2IR + V_b = 0$$

or $$2IR = V_a - V_b \quad \text{...(iii)}$$

From equations (iii) and (iv), we get

$$\begin{aligned} V_o &= -2(V_a - V_b) \\ &= 2(V_b - V_a) \end{aligned} \quad \text{...(iv)}$$

Since, the voltage at inverting and non-inverting terminals are same for ideal op-amp. So, from the op-amp circuit, we have

$$V_1 = V_b \text{ and } V_2 = V_a$$

Substituting it in equation (iv), we obtain

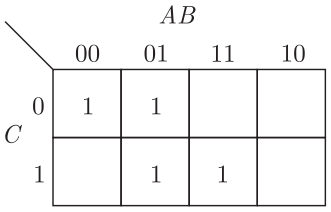
$$V_o = 2(V_1 - V_2)$$

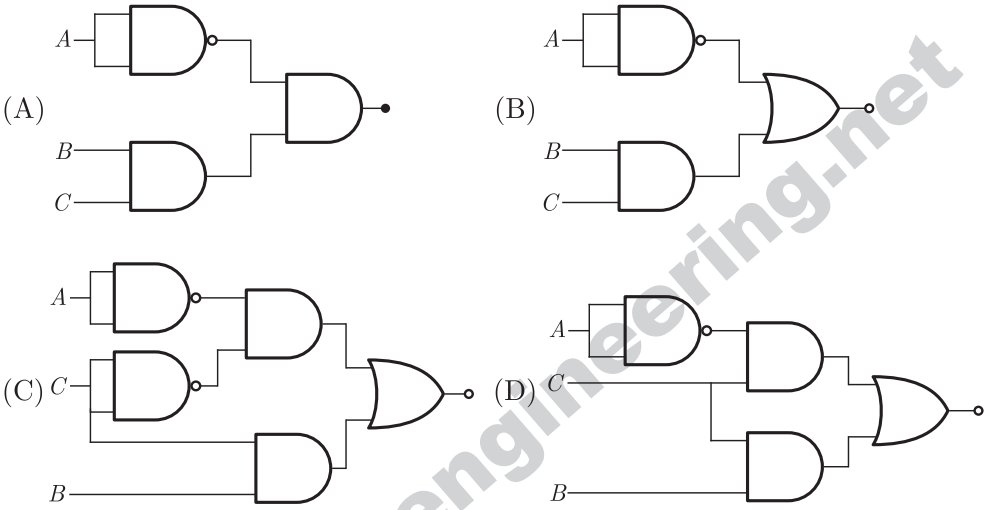
www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

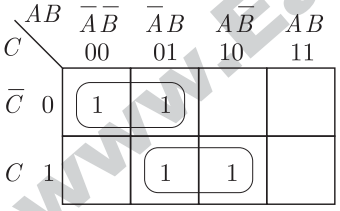
Q. 50 Which of the following logic circuits is a realization of the function F whose Karnaugh map is shown in figure





Sol. 50 Correct option is (C).

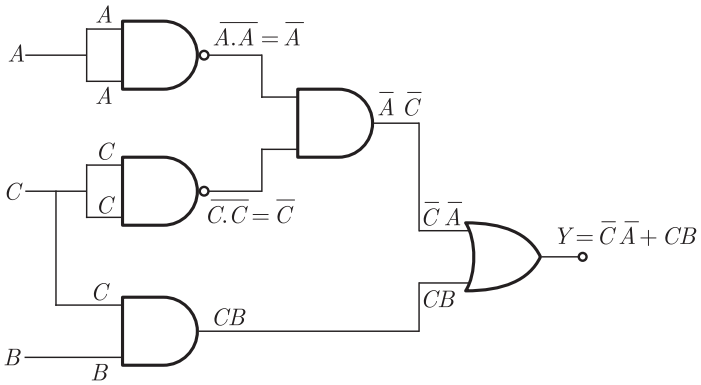
Using minimization technique, we redraw the given Karnaugh map as



For the given Karnaugh map, the output function is

$$Y = \overline{C}\,\overline{A} + CB$$

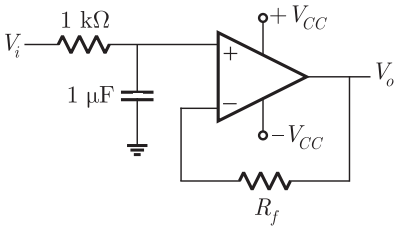
This function is realized by the logic circuit shown below.



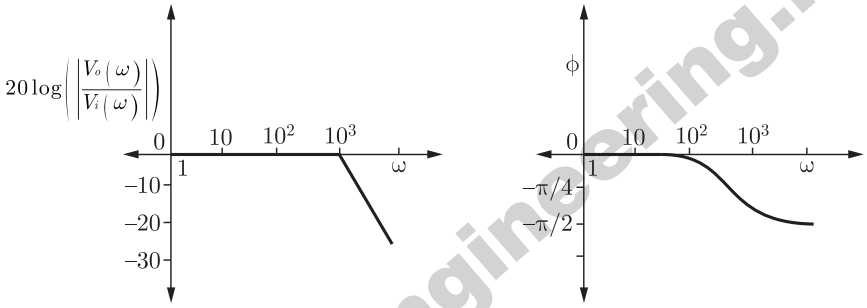
Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

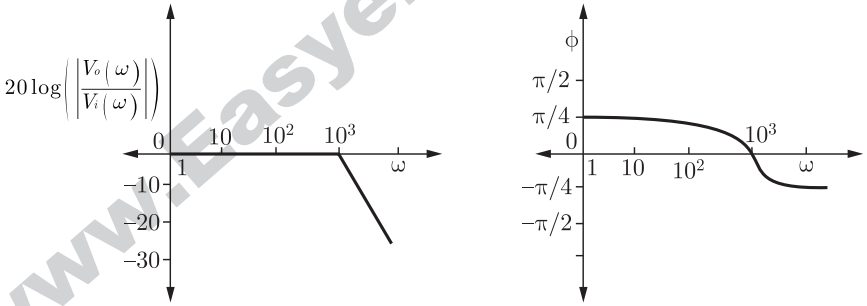
Q. 51 In the figure shown, assume the op-amp to be ideal. Which of the alternatives gives the correct Bode plote for the transfer function $\frac{V_i(\omega)}{V_i(\omega)}$?



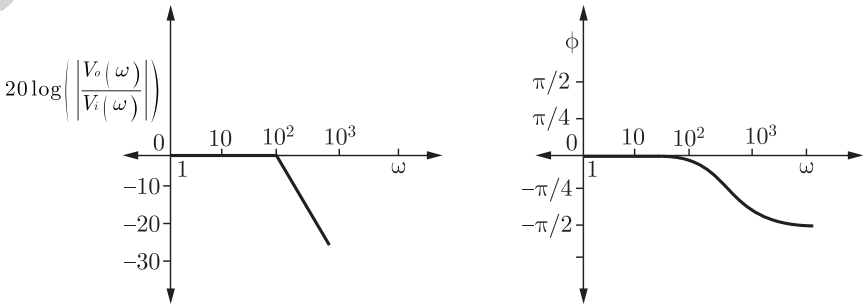
(A)



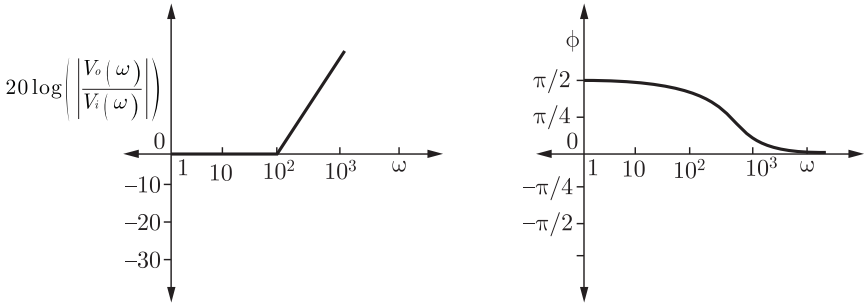
(B)



(C)



(D)



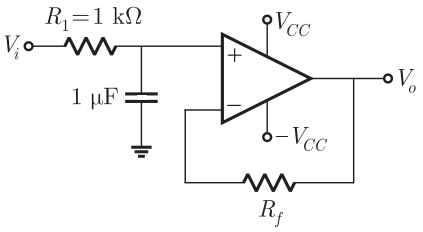
www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Sol. 51 Correct option is (A)

We have the op-amp circuit



Let the voltage at inverting terminal of op-amp be X. So, we have

$$\frac{X(s) - V_o(s)}{R_f} = 0$$

or $$X(s) = V_o(s) \quad \text{...(i)}$$

Applying KCL at non-inverting terminal of op-amp, we get

$$[X(s) - 0]Cs + \frac{X(s) - V_i(s)}{R_1} = 0$$

or $$X(s)\left[Cs + \frac{1}{R_1}\right] = \frac{V_i(s)}{R_1}$$

or $$V_o(s)\left[\frac{R_1Cs + 1}{R_1}\right] = \frac{V_i(s)}{R_1} \quad \text{[from equation (i)]}$$

So, $$\frac{V_o(s)}{V_i(s)} = \frac{1}{1 + R_1Cs} = \frac{1}{1 + 10^{-3}}$$

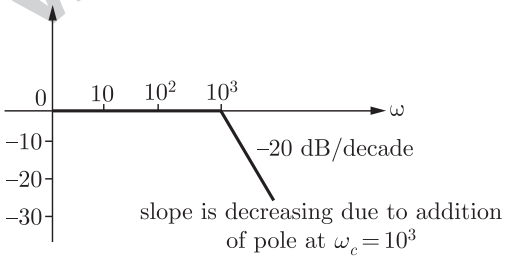
Therefore, the corner frequency for the transfer function is

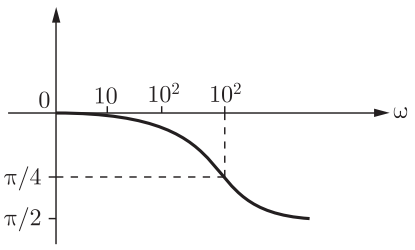
$$\omega_C = \frac{1}{10^{-3}} = 10^3$$

Hence, we draw the Bode plot for the function (in decibel),

$$20\log\left|\frac{V_o(\omega)}{V_i(\omega)}\right| = 20\log\left(\frac{1}{1 + \frac{j\omega}{10^3}}\right)$$

The obtained magnitude and phase plots are



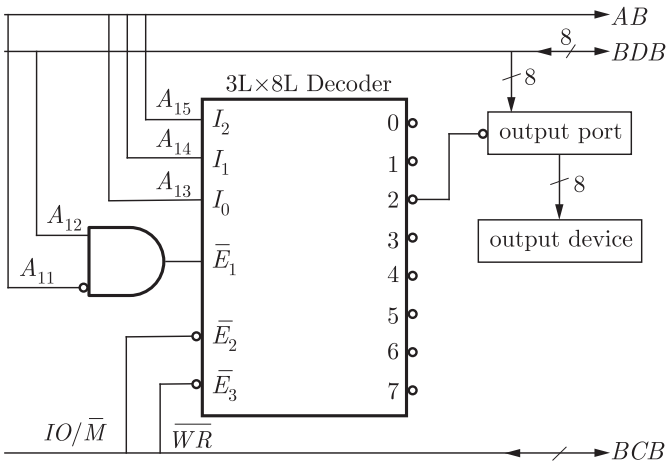


Q. 52 An output device is interfaced with 8-bit microprocessor 8085A. The interfacing circuit is shown in figure

www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net



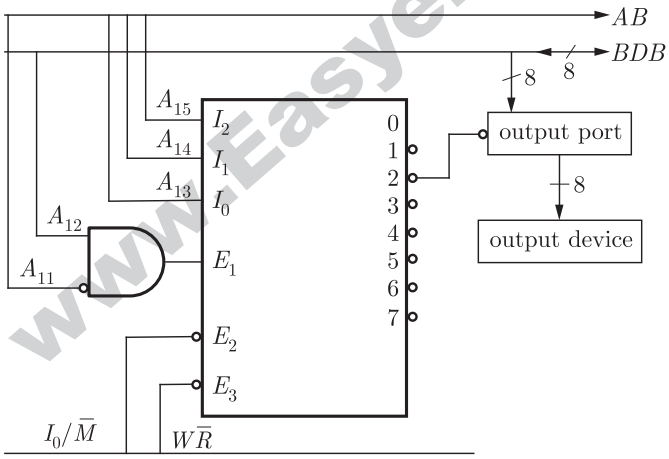
The interfacing circuit makes use of 3 Line to 8 Line decoder having 3 enables lines E_1, $\overline{E}_2$, $\overline{E}_3$. The address of the device is

(A) 50_H (B) 5000_H

(C) $A0_H$ (D) $A000_H$

Sol. 52 Correct option is (B).

Given the interfacing circuit,



As the output port is at 2(010). Hence, the input to the interfacing circuit is

$$I_2I_1I_0 = 010$$

or $$A_{15}A_{14}A_{13} = 010$$

Now, for E_1 to be enable, we have

or $$A_{12}A_{11} = 10$$

Therefore, we have the value at address lines as

A_{15}	A_{14}	A_{13}	A_{12}	A_{11}
0	1	0	1	0

By default at starting the other address lines $A_{10}A_9.....A_0$ should be zero. Thus, we have the overall port address as

A_{15}	A_{14}	A_{13}	A_{12}	A_{11}	A_{10}	A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0
0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0

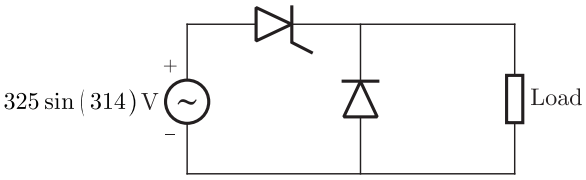
which is equivalent to 5000 H

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

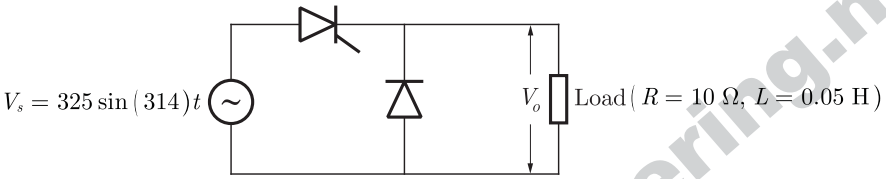
Downloaded From : www.EasyEngineering.net

Q. 53 The figure shows the circuit diagram of a rectifier. The load consists of a resistance $10\,\Omega$ and an inductance 0.05 H connected in series. Assuming ideal thyristor and ideal diode, the thyristor firing angle (in degree) needed to obtain an average load voltage of 70 V is _ _ _ _.



Sol. 53 Correct answer is 69.35°.

We have the rectifier circuit as



From the circuit, we obtain

$$V_o = \frac{1}{2\pi}\int_{\alpha}^{\pi} V_m \sin\omega t d(\omega t)$$

$$= \frac{1}{2\pi} V_m \left[-\cos\omega t\right]_{\alpha}^{\pi}$$

$$= \frac{1}{2\pi} V_m \left[1 + \cos\alpha\right] \quad \ldots(i)$$

Since, from the given problem, we have

$$V_o = 70 \text{ V}; V_m = 325 \text{ V}$$

Substituting it in equation (i), we get

$$70 = \frac{1}{2\pi} 32.5[1 + \cos\alpha]$$

or $$1 + \cos\alpha = \frac{70 \times 2\pi}{325}$$

or $$1 + \cos\alpha = 1.3526$$

or $$\cos\alpha = 0.3526$$

Thus, $$\alpha = \cos^{-1}(0.3526)$$

$$= 69.35^\circ$$

Q. 54 Figure (i) shows the circuit diagram of a chopper. The switch S in the circuit in figure (i) is switched such that the voltage v_D across the diode has the wave shape as shown in figure (ii). The capacitance C is large so that the voltage across it is constant. If switch S and the diode are ideal, the peak to peak ripple (in A) in the inductor current is _ _ _ _ _ _

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

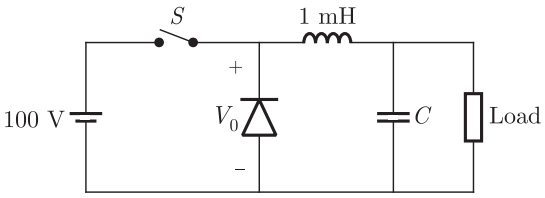


Figure (i)

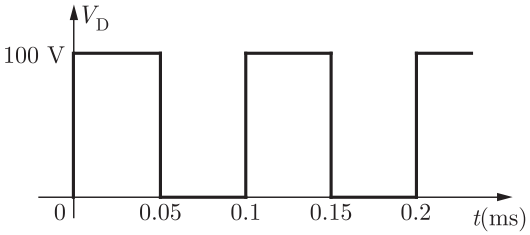
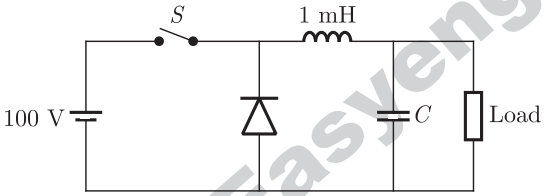


Figure (ii)

Sol. 54 Correct answer is 2.5 A.

We have the chopper circuit as



Since, the circuit is a buck regular. So, we have

$$V_o = V_s \times \alpha \qquad (\alpha = \text{duty cycle})$$

$$= 100 \times \frac{0.05}{0.1}$$

$$= 50 \text{ V}$$

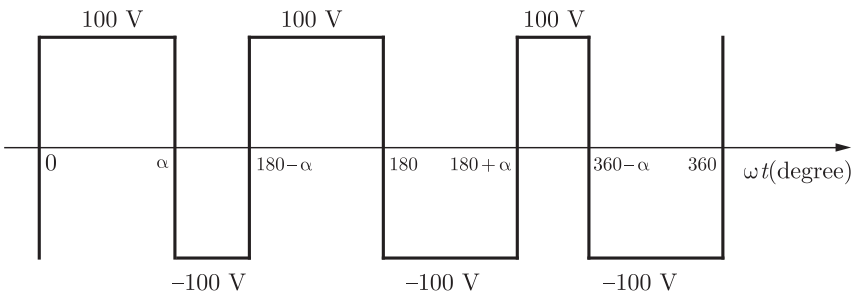
Therefore, peak to peak inductor ripple current is obtained as

$$\Delta I = \frac{V_o \times \Delta t}{L}$$

$$= \frac{50 \times 0.05\,(\text{m sec})}{1\,\text{mH}}$$

$$= 2.5 \text{ A}$$

Q. 55 The figure shows one period of the output voltage of an inverter α should be chosen such that $60^\circ < \alpha < 90^\circ$. If rms value of the fundamental component is 50 V, then α in degree is _ _ _ _ _.



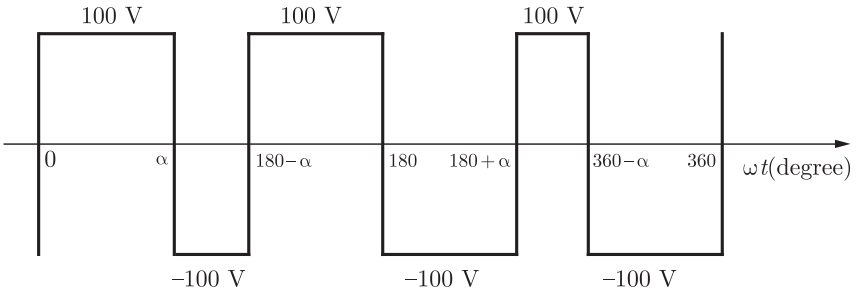
www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

Sol. 55 Correct answer is 77.15°

Given the output voltage of an inverter as



Since, the output voltage is an odd function, so we compute only sine terms for the given period

$$V_{\max} = \frac{2}{T}\int_0^T v(t)\sin(\omega_o t)dt$$

From the output wave, we have

$$T = 360^\circ = 2\pi$$

and $$\omega_o = \frac{2\pi}{T} = \frac{2\pi}{2\pi} = 1$$

So, we get the maximum value of fundamental component as

$$V_{\max} = \frac{2}{2\pi}\left[\int_0^{\alpha} 100\sin t dt - \int_{\alpha}^{180-\alpha} 100\sin t dt + \int_{180-\alpha}^{180} 100\sin t dt - \int_{180}^{180+\alpha} 100\sin t dt + \int_{180+\alpha}^{360-\alpha} 100\sin t dt - \int_{360-\alpha}^{360} 100\sin t dt\right]$$

$$= \frac{100}{\pi}[(1-\cos\alpha) - (\cos\alpha + \cos\alpha) + (1-\cos\alpha) + (-\cos\alpha - \cos\alpha) - (-1+\cos\alpha)]$$

$$= \frac{100}{\pi}[4 - 8\cos\alpha]$$

$$= \frac{400}{\pi}[1 - 2\cos\alpha] \quad ...(i)$$

Since, the rms value is

$$V_{rms} = 50 \text{ V}$$

$$\frac{V_{\max}}{\sqrt{2}} = 50$$

Substituting it in equation (i), we get

$$\frac{400}{\pi\sqrt{2}}(1-\cos\alpha) = 50$$

or $$\cos\alpha = \frac{1}{2}\left[1 - \frac{50 \times \pi\sqrt{2}}{400}\right]$$

Thus, $$\alpha = 77.15^\circ$$

END OF THE QUESTION PAPER

****

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net

Downloaded From : www.EasyEngineering.net

ANSWER KEY

General Aptitude									
1	2	3	4	5	6	7	8	9	10
(B)	(C)	(C)	(96)	(D)	(C)	(B)	(850)	(48)	(6)

Electrical Engineering									
1	2	3	4	5	6	7	8	9	10
(B)	(A)	(C)	(B)	(C)	(330)	(A)	(C)	(C)	(C)
11	12	13	14	15	16	17	18	19	20
(3.2-3.5)	(C)	(14.5-15.5)	(B)	(C)	(B)	(B)	(C)	(C)	(B)
21	22	23	24	25	26	27	28	29	30
(C)	(C)	(D)	(23)	(C)	(0.5)	(B)	(B)	(2470-2471)	(10)
31	32	33	34	35	36	37	38	39	40
(C)	(C)	(A)	(B)	(B)	(A)	(1239-1242)	(C)	(A)	(D)
41	42	43	44	45	46	47	48	49	50
(B)	(D)	(0.21-0.23)	(0.61-0.63)	(0.7-0.8)	(2.9-3.1)	(140-142)	(3.0-3.4)	(B)	(C)
51	52	53	54	55					
(A)	(B)	(69-70)	(2.49-2.51)	(76.5-78.0)					

www.Easyengineering.net

Downloaded From : www.EasyEngineering.net